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CHILDREN'S CONCEPTS OF BASE AREA SYMBOLS

by

MERVYN LEROY PEDDE

A THESIS

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The undersigned certify that they have read, and recommend to the Faculty of Graduate Studies for acceptance, a thesis entitled "Children's Concepts of Base Area Symbols," submitted by Mervyn Leroy Pedde, B. Ed., in partial fulfilment of the requirements for the degree of Master of Education.

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ABSTRACT

The purpose of this study was to examine the development of children's understanding of map symbolization in grades one through six. The spatial representation of the base area symbol was selected for investigation because it is probably the simplest of all map symbols. The study also examined the relationship between the development of the concept of base area symbols and such reportedly related factors as sex, socio-economic status, chronological age, intelligence, grade level, and experience in the form of recent air travel.

A task-type test consisting of two series of tasks containing five and four tasks respectively was constructed and administered individually to examine each subject's concept of base area symbols. The basis for all tasks was a three-dimensional model town consisting of four blocks of realistic buildings. The Lorge Thorndike Intelligence Test, nonverbal form B was also administered to the subjects in group situations. The sample of one hundred twenty children was composed of ten males and ten females at each grade from one through six at two schools in the Edmonton, Alberta Public School System. The twenty subjects, at the time of testing in May and June, 1965, ranged in age from six years seven months to twelve years seven months and had intelligence quotients ranging from seventy-one to one hundred forty-three as measured by the Lorge Thorndike Test. The subjects were classified into socio-economic status groups using the Blishen Occupational Class Scale.

A record of the children's performance on each of the various tasks was completed. Additional non-objective observations were recorded, analyzed and reported. Statistical analyses were applied to the scores of the children in an attempt to clarify the relationships being investigated.

The principal findings of this study were as follows:

1. Sex, socio-economic status, and recent air travel experience were not significantly correlated with the development of the concept of base area symbols.

2. Chronological age, intelligence, and grade level were significantly correlated with the development of the concept of base area symbols.

3. There was a sequence of development in the ability to use and understand base area symbols in grades one through six. However, at each grade level there was found to be substantial range among the children in their ability to use and understand base area symbols.

4. Problems encountered by subjects in map drawing were generally concerned with the size of the symbol, the location of the symbol, and the proper type of symbol. Buildings were frequently represented in profile rather than in plan.

5. Subjects encountered difficulty with left-right, before-behind relations. Mirror images and reversals were common at the lower grades.

A number of implications for educational programs and suggestions for further research are presented.

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CHAPTER I

INTRODUCTION

Curriculum projects in the separate disciplines in the social sciences have been conducted in parts of Canada and the United States during the last few years. In general, there has been an attempt to determine what aspects of each discipline should make up part of the school curriculum in social studies so that existing curricula can be revised. In geography, as in the other disciplines, an effort has been made to determine the structure of the subject[1], to establish the appropriate levels at which to teach elements of the subject, and to devise effective teaching procedures.

The map is one of the tools of the geographer used in the investigation and presentation of subject matter of a geographical nature. Despite a number of weaknesses, flat maps are primary devices for enlarging man's concept of the world. These short-hand records of geographic knowledge represent an almost inexhaustible supply of information to those who have the skills and abilities necessary for interpreting them. Spatial aspects of places such as distance, direction, scale, and both exact and relative location are important aspects of any map. In addition, the map symbols represent cultural as well as natural phenomena and become the language of the map.

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[1]For a discussion of the structure of subjects see Jerome S. Bruner, The Process of Education, (Cambridge: Harvard University Press, 1960).

The majority of elementary social studies curricula include map study programs which contain sequences of learnings which children at various grade levels are expected to master. While it is a widely accepted principle that materials with which a child is asked to work should be adapted to his level of ability and stage of development, the majority of map study programs have been based on limited observation, logic, and judgment rather than on sound research evidence.

The association between the symbol and the reality it represents appears to be the major problem facing children attempting to read maps for, as Satterly quoting The Teaching of Geography has said, "It is too lightly assumed that the child has an idea of the reality behind the map".[2] The language of the map can only be understood when the child can produce a mental image of the reality which each symbol represents.

I. THE PROBLEM

The purpose of this study was to examine the development of children's understanding of map symbols in grades one through six. The spatial representation of the base area symbol was selected for investigation because it is probably the simplest of all map symbols and children of all ages have direct contact with the reality represented by base area symbols.

A child must be able to perform two separate operations in order

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[2] The Teaching of Geography, The I.A.A.M. (1956), cited by David J. Satterly, "Skills and Concepts involved in Map Drawing and Interpretation", The New Era in Home and School, XLV (November, 1964), 260.

to demonstrate full understanding of a map symbol. First, he must be able to represent such three dimensional objects as buildings by the use of base area symbols. This requires a two dimensional plan of reality. Second, the child must be able to visualize the reality that is represented by each symbol. These two operations are the basic ones involved in making and reading a map. Thus, through placing the children of a selected sample in a number of test situations, this study was designed to examine their ability to represent three dimensional objects in two dimensions and to examine their ability to visualize the object that each symbol represents.

The Research Hypotheses

1. There is a sequence of development in the ability of children to represent three dimensional objects by the use of base area symbols.

2. There is a sequence of development in the ability of children to visualize the objects represented by base area symbols.

3. Children are able to represent three dimensional objects by the use of base area symbols at an earlier stage than they are able to visualize the objects that are represented by the base area symbols.

The Null Hypotheses

The development of children's understanding of map symbols in grades one through six was examined in an effort to determine its relationship with factors reportedly relevant to concept development such as sex, socio-economic status, chronological age, intelligence, and grade level. In addition, the relationship between recent air travel experience

and understanding of map symbols was examined. To determine these relationships the following null hypotheses were tested.

1. There is no significant correlation between the ability of males and females to represent three dimensional objects by the use of base area symbols as measured by the Base Area Symbols Test.

2. There is no significant correlation between socio-economic status and the ability to represent three dimensional objects by the use of base area symbols as measured by the Base Area Symbols Test.

3. There is no significant correlation between chronological age and the ability to represent three dimensional objects by the use of base area symbols as measured by the Base Area Symbols Test.

4. There is no significant correlation between intelligence and the ability to represent three dimensional objects by the use of base area symbols as measured by the Base Area Symbols Test.

5. There is no significant correlation between grade level and the ability to represent three dimensional objects by the use of base area symbols as measured by the Base Area Symbols Test.

6. There is no significant correlation between recent air travel experience and the ability to represent three dimensional objects by the use of base area symbols as measured by the Base Area Symbols Test.

7. There is no significant correlation between the ability of males and females to visualize objects represented by base area symbols as measured by the Base Area Symbols Test.

8. There is no significant correlation between socio-economic

status and the ability to visualize the objects represented by base area symbols as measured by the Base Area Symbols Test.

9. There is no significant correlation between chronological age and the ability to visualize the objects represented by base area symbols as measured by the Base Area Symbols Test.

10. There is no significant correlation between intelligence and the ability to visualize the objects represented by base area symbols as measured by the Base Area Symbols Test.

11. There is no significant correlation between grade level and the ability to visualize the objects represented by base area symbols as measured by the Base Area Symbols Test.

12. There is no significant correlation between recent air travel experience and the ability to visualize the objects represented by base area symbols as measured by the Base Area Symbols Test.

13. There is no significant correlation between the total score obtained by each subject on section A of the Base Area Symbols Test dealing with the representation of three dimensional objects by the use of base area symbols and the total score obtained by each subject on section B of the same test dealing with the visualization of objects represented by base area symbols.

II. THE SIGNIFICANCE OF THE STUDY

What are the basic map skills children should acquire? When should they be taught? How should they be taught? These three questions, crucial

to the area of map reading as they are to any other curriculum area, need to be answered before a sequential, research based, program of map skills can be developed to revise this aspect of current social studies programs.

Many writers in the field of map reading agree with Mitchell who has stated that:

> The ability to use maps . . . is not acquired incidentally or automatically . . . ; it must be taught in a carefully planned sequence beginning in the primary grades and developed slowly, gradually, deliberately, with no point of absolute completion.[3]

While Mitchell and other writers such as Sabaroff[4], Bathurst[5], and Trail[6] have stressed readiness programs for map reading in the primary grades followed by the gradual development of concepts, others such as Shyrock[7], Garnett[8], Sorohan[9], Satterly[10] and Prior[11] suggested the fourth grade as

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[3]Edna S. Mitchell, "Introducing Maps--A Skill," Childhood Education, XXXVII (February, 1961), p. 279.

[4]Rose Sabaroff, "Map Interpretation in the Primary Grades," The Elementary School Journal, LXIV (1963), pp. 59-67.

[5]Leonard H. Bathurst, "Developing Map Reading Skills," The Journal of Geography, LX (1962), pp. 26-32.

[6]Robert W. Trail, "Maps in the Primary Grades," Ibid., LI (September, 1952), pp. 238-244.

[7]Clara M. Shyrock, "Gradations in Map Learning," Ibid., XXXVIII (1939), pp. 181-187.

[8]Olive Garnett, Fundamentals in School Geography (Toronto: George G. Harrap and Co., Ltd., 1960).

[9]Lawrence Joseph Sorohan, "The Grade Placement of Map Skills According to the Mental Ages of Elementary School Children" (Unpublished Ph. D. dissertation, Ohio University, 1962).

[10]Satterly, op. cit.

[11]F. M. Prior, "The Place of Maps in the Junior School" (Unpublished dissertation, University of Birmingham, England, 1959).

the earliest level for the beginning of map work and postponed it as far as fifth or sixth grade.

The lack of agreement about the appropriate level at which to introduce map work results in the problem of what basic skills of map reading should be taught and what methods are most effective. Hardwick and Midgley assert that present programs of study are not adequate for they ". . . give the teacher confused guidance in deciding what skills he should teach and and the manner in which he should teach them."[12] Barton recently summed up the present situation by saying that

> It is impossible to design . . . a precise numbered sequence for developing geography skills because as yet insufficient evidence has been collected by research in the behavioral sciences, experimental teaching, diagnostic testing, and other kinds of research. All that is available today are some suppostions as to what is or is not too difficult for various groupings, and some suggestions concerning a sequence of techniques based on limited observation, logic, and judgment.[13]

This study is designed to examine the development in children of one skill deemed necessary in map reading. It is hoped that findings of this study may provide information which could be used in developing a sequential plan for teaching map symbolization, reading, and interpretation which will meet the needs of children at various stages of

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[12]F. C. Hardwick and Cyril Midgley, Understanding Maps (Toronto: Clarke, Irwin and Company, Ltd., 1961), p. 9.

[13]Thomas F. Barton, "Geography Skills and Techniques," Curriculum Guide for Geographic Education, Wilhelmina Hill, editor (Oklahoma City: Harlow Co., 1964), p. 69.

of development. Additionally, it is hoped that the findings of this study may supplement those of a similar study of map skills recently completed by Towler[14] and that the findings may extend present knowledge in the area of children's conception of space. This study, somewhat exploratory in nature, may suggest additional opportunities for, or approaches to, further studies.

III. DEFINITION OF TERMS

For purposes of this study, the following definitions were used.

Base Area. The plan, the representation of the horizontal section at the base.

Base Area Symbol. A two-dimensional line drawing obtained by drawing a line around the base of one of the realistic buildings used in the model or by drawing a figure having length and width only.

Two-Dimensional Symbols. A base area symbol. Where the symbols were provided they were made of thin cardboard.

Three-Dimensional Symbol. A representation having length, width, and height. In this study, the symbols to represent buildings were made of white styrofoam.

Model Town. A commercially available toy representation of a small town, 31' x 43', consisting of four blocks separated by streets and avenues. Four realistic buildings were found on each of three blocks and the fourth

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[14] J. O. Towler, "Spatial Concepts of Elementary School Children" (Unpublished Master's thesis, The University of Alberta, Edmonton, 1965).

block had three buildings and three automobiles. Small model trees were found on each block.[15]

Block. The area included in one-fourth of the model town.

Map. A two-dimensional representation of part or all of the model town using base area symbols to represent the buildings.

Visualize. The subject is capable of forming a mental image of or understanding something which is not seen.

Concept. An idea; a mental image formed by generalization from particulars.

Ability to visualize. The overt behavior of the subject on each task was taken as his ability to understand or "to visualize".

High socio-economic status. The position of a subject who is supported by an adult whose occupation ranks in class one or two of the Blishen Occupational Class Scale.[16]

Low socio-economic status. The position of a subject who is supported by an adult whose occupation ranks in class six or seven of the Blishen Occupational Class Scale.

Grade. A year of formal education. Children who were accelerated or who repeated a year at school were excluded from the population so the term "grade one through six" was equivalent to years in school one through six.

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[15] See figures 2-7, Infra.

[16] B. R. Blishen, "The Construction and Use of an Occupational Class Scale," Canadian Society, B. R. Blishen, (ed.), New York: McMillan (The Free Press of Glencoe, Inc.), 1961, pp. 477-485.

Base Area Symbols Test. An instrument consisting of nine tasks prepared by the researcher to test the null hypotheses. A detailed description of the test appears in Appendix B.

Sequence of development. The gradual and continuous growth in ability to perform through the grades one to six.

Profile. An outline of the side elevation of the buildings in the model town. The elevation.

Rotation. An horizontal representation of a vertical plane. Where a subject has drawn on the horizontal plane what should be on the vertical plane it is said to be "rotated" or that "rotation" has occurred.

Recent air travel experience. Travel in an aircraft within a period of two years prior to the testing program.

IV. EXPERIMENTAL SETTING

A sample of one hundred thirty-two children consisting of eleven males and eleven females at each of grades one through six, was selected at random from three schools in the Edmonton Public School System. One male and one female at each of the six grades at one of the three schools was used for the pilot study. The remaining ten males and ten females at each grade from one through six were used for the main study. The test battery, administered in May and June, 1965, consisted of an intelligence test and two series of task-type tests. The intelligence test was administered in group setting while the latter test, the Base Area Symbols Test, was administered to each subject individually. Some of the tasks in the

Base Area Symbols Test were modifications of tests used by Piaget in his study of spatial concepts of children and some of the tasks were developed by the investigator. Five of the nine tasks required manipulation of objects, three required identification, and one required the subject to make a drawing. A complete description of the test may be found in Appendix B.

V. ASSUMPTIONS AND LIMITATIONS

The design of this study was based on the following assumptions.

1. Since the tasks comprising the Base Area Symbols Test were replications of, or patterned after items used by Piaget in previous investigations, and since the investigator determined to incorporate other factors which were reportedly related, it was assumed that it was a valid and reliable measure of the concept under investigation. This assumption that the test was valid was based on Kerlinger's statement that, "Whenever hypotheses are tested, whenever relations are empirically studied, construct validity is involved".[17]

2. The subject's overt behavior on each task was indicative of his understanding of the concept.

3. The method of scoring and the number of points assigned to each task were realistic and were consistent throughout.

4. After it was ascertained that no special program of map instruction existed in the schools used in this study, it was assumed that

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[17]Fred N. Kerlinger, Foundations of Behavioral Research (New York: Holt, Rinehart and Winston, Inc., 1964), pp. 451-452.

all children in the sample had similar opportunities for learning provided at each school and at each grade level.

5. The amount of learning throughout performance of the tasks was the same for all subjects.

6. The ability to make a map and to interpret map symbols in relation to a specific model used in this study was a valid measure of the same skills used in classroom situations involving maps.

The study was also subject to the following limitations.

1. This study was confined to the reading and interpretation of base area symbols which are considered as only one aspect of the skills required in map reading.

2. The tasks dealt only with the ability to visualize cultural features represented by base area symbols. Physical features and their appropriate symbols were not considered.

3. The study was limited to a sample of one hundred twenty children in grades one to six selected from the population at two elementary schools in Edmonton, Alberta. Children who were accelerated, who repeated a grade, or who were recent immigrants were not included in the sample. Therefore, results of this study were limited to be relevant to this sample rather than the total population in grades one to six.

VI. OVERVIEW

The remainder of this report is organized into four chapters. Chapter II presents a review of the literature which is related to the

problem under study. The first part of the chapter reviews the non-empirical literature on map skills, the second part reviews the research related to map reading and the final part presents psychological investigations relevant to map drawing and map reading. Chapter III describes the design of the experiment in sections dealing with the sample, the instrument, the testing program, scoring procedures, and statistical treatment of the data. Chapter IV is devoted to an outline of the results of the investigation. Chapter V summarizes the study and includes conclusions and implications.

CHAPTER II

A REVIEW OF RELATED LITERATURE

Among the objectives of many elementary social studies programs is the development of skills. One skill stated to be desirable in all texts and syllabuses examined by the investigator is the making and reading of globes and maps. Kennamer has stated that "the many abilities necessary for reading and interpreting them (maps) accurately are not innate--they must be developed over a period of time beginning with the early grades and continuing through early college years."[1] It is implied that skills are necessary for map reading and interpretation, that they must be taught and that they must be taught over a period of time. Much literature in this area, based on observation, logic, judgment, and limited research, has attempted to provide answers to the questions as to what skills are to be taught, when they are to be taught, and how they are to be taught. Answers to these questions, which are of vital interest to curriculum writers and teachers, are inconclusive for as Barton has said, ". . . as yet insufficient evidence has been collected by research in the behavioral sciences, experimental teaching, diagnostic testing, and other kinds of research."[2]

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[1]Lorrin Kennamer, "Developing a Sense of Place and Space," Skill Developments in Social Studies, Thirty-Third Yearbook of the National Council for Social Studies, (Washington: NCSS, 1963), p. 156.

[2]Thomas F. Barton, Geography Skills and Techniques," Curriculum Guide for Geographic Education, Wilhelmina Hill, editor (Illinois: National Council for Geographic Education, 1964), p. 69.

This chapter contains a review of the non-empirical literature related to the basic map skills, the research related to map reading, and of the psychological investigations most relevant to map drawing and map reading. A discussion and summary of this literature is provided at the end of the chapter.

I. NON-EMPIRICAL LITERATURE RELATED TO BASIC MAP SKILLS

Maps record geographic and other knowledge by the use of a kind of shorthand or "map language". This "language" has to be learned like any other language. The purpose of learning the map language, it is generally agreed, is not to learn to read maps as an end in itself but rather to read maps to learn. Special skills which appear to be needed in order to read and interpret maps are developed gradually and children require definite instruction in order to require them. Kohn suggested that the following constitute a comprehensive and basic set of skills in a program of map reading and interpretation:

(1) Ability to orient the map and note directions.
(2) Ability to recognize the scale of a map and to compute distances.
(3) Ability to locate places on maps . . . by means of grid systems.
(4) Ability to express relative locations.
(5) Ability to read map symbols.
(6) Ability to compare maps and make inferences.[3]

Skill in the reading and interpretation of maps and globes is asserted to develop gradually and must be part of a carefully planned

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[3]Clyde F. Kohn, "Interpreting Maps and Globes," Skills in Social Studies, Twenty-Fourth Yearbook of the National Council for the Social Studies (Washington: The Council, 1953), pp. 146-147.

sequence of instruction. Some of the many skills can be introduced in the early grades but need to be reviewed and developed throughout the school career of a child if they are to become effective. It is commonly agreed that instruction should be given at a time when a child is required to use a map for a specific purpose. Writers and teachers alike would generally agree with Jarolimek who has stated that, "Map reading is a developmental process. Map reading and associated interpretive skills and abilities are not taught to completion at any one school level."[4]

Map reading and map interpretation, though related, are separate processes which must each be taught for a thorough development of map skills. Lobeck has said:

> Map reading is what all of us do when we want to find out where a place is on the map, or the distance between places . . . , or any simple geographical fact . . . . But map interpretation is like the process of reading between the lines of a story whereby the reader draws certain inferences and conclusions which the author did not specifically make.[5]

Thus, it is asserted that new depths of meaning can be added to, or derived from, the symbols and the reality they represent by an extension of the messages they convey.

A map itself is a very abstract and complex symbol which is interpreted through the use of other symbols. Although map symbols are not as numerous as word symbols, they are in many ways more complex. Many symbols placed on maps are representations of concrete objects such as houses,

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[4]John Jarolimek, Social Studies in Elementary Education (New York: The Macmillan Company, 1963), p. 247.

[5]Armin K. Lobeck, Things Maps Don't Tell Us (New York: The Macmillan Company, 1958) p. x.

bridges, mountains, and rivers. However, many symbols placed on maps are representative of abstract ideas such as political boundaries which are not visible in reality. Pupils must completely understand the symbols of a map if it is to be used effectively in the classroom.

Bathurst said that, "The reader must know that it (a map) is a 'birds eye view', drawn with lines, of a given area or section of the earth."[6] In all other respects it is purely symbolic. Symbols represent the natural and cultural features found on the earth. It is the process of associating the map symbol with the actual object or idea being represented that often causes difficulty for the student. A map symbol does not stand for a word and so being able to name a symbol does not mean that a child can understand the symbol or its word name. "It is quite obvious," said Sabaroff "that only when a map symbol calls forth a mental image in the mind of the child, can he use the map "shorthand" with any significant meaning."[7] With each symbol he has learned, the student is able to get a new understanding of the earth and man. This is as true of map symbols as it is of the printed word.

One of the chief causes of failure to learn to read maps appears to be the child's inability to "see in his mind's eye" the reality that the map symbols represent. However, many social studies reference books at the

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[6]Leonard H. Bathurst, "Developing Map Reading Skills," The Journal of Geography, LX (1962), p. 26.

[7]Rose Sabaroff, "Improving the Use of Maps in the Elementary School," The Journal of Geography, LX (1961), p. 184.

grades three and four level contain maps of foreign countries. The writers of these books assume that by placing a map before the child he will learn from it. Yet Renner suggested that any teacher placing a map before the child and questioning him about it before he is ready is ". . . committing an educational enormity."[8] Parker further stated that:

> Children should not be allowed to get their first ideas of the appearance of a given kind of feature from the map . . . . Introducing symbols of features children have not seen in real or printed landscapes is one of the chief causes of failure to learn to read maps--that is, to see <u>through</u> them to the <u>realities</u> that map symbols represent.[9]

In order to see through the symbols on a map to the realities the symbols represent, it is imperative that children begin a study of the known physical or cultural landscape. Various writers such as Mitchell[10], Sabaroff[11], Moore[12], Owen[13], Garnett[14], Hardwick[15], and Thralls[16] to name

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[8]George T. Renner, "The Map in Modern Education," <u>Teacher's College Record</u>, XL (1939), p. 707.

[9]E. P. Parker, <u>Seeing Our World Through Maps</u> Illinois: Weber Costello Co., (1942), p. 6.

[10]Edna S. Mitchell, "Introducing Maps--A Skill," <u>Childhood Education</u>, XXXVII (1961), pp. 279-283.

[11]Rose Sabaroff, "Map Interpretation in the Primary Grades," The <u>Elementary School Journal</u>, LXIV (1963), pp. 59-67.

[12]Evelyn R. Moore (ed.), <u>Geography in Elementary Social Studies</u> (Edmonton: Social Studies Council, A.T.A., 1963).

[13]E. E. Owen, "Mapwork in the Upper Elementary School". (Mimeo., n.d.)

[14]Olive Garnett, <u>Fundamentals in School Geography</u> (Toronto: George G. Harrap and Co., Ltd., 1960).

[15]F. C. Hardwick and Cyril Midgley, <u>Understanding Maps</u> (Toronto: Clarke, Irwin & Company, Ltd., 1961.

[16]Zoe A. Thralls, <u>The Teaching of Geography</u> (New York: Appleton-Century-Crofts, Inc., 1958).

a few, have suggested that outdoor observations and excursions within the child's own neighborhood are necessary prerequisites to a map making and map reading program. Following the excursion, young children, it is recommended, should record their observations in the form of a large three-dimensional layout on the floor or on large paper. Buildings are represented by "buildings" made by the children or by three-dimensional symbols such as cardboard boxes. Mitchell has suggested that at this point children draw a flat map on the floor beside the three-dimensional map. Bathurst[17] suggested making a three-dimensional sand map after the floor layout but that the vertical flat maps can follow at this point. However, a program in mapping skills conducted at the University School in Edmonton indicated that replacing the three-dimensional symbols with two-dimensional symbols made of cardboard, and drawing a line around either the two or three-dimensional symbols in order to produce the base area symbols, seemed excellent intermediary steps between the three-dimensional and flat maps. Sabaroff, Moore, and Owen would agree with Parker when she said:

> Maps . . . can have meaning only through abundant experience in translating landscapes observed <u>into</u> maps, and map symbols into landscape realities. Experiences essential in so doing are needed in connection with every locality studied. It is only as one learns gradually to translate landscapes into maps that one can, in turn, acquire the ability to use maps in gaining those concrete concepts of the whole world . . . .[18]

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[17] Bathurst, <u>op. cit.</u>

[18] E. P. Parker, "Major Conclusions to be Drawn from the Investigations," <u>The Teaching of Geography</u>, Thirty-Second Yearbook of the National Society for the Study of Education (Bloomington: Public School Publishing Co., 1933), pp. 12-13.

Sabaroff suggested further that the aerial or vertical photograph is a useful instrument as a step from three-dimensional symbols to more abstract symbolization. The relationship between the base area symbolization and the vertical photograph is important in visualizing more abstract symbols on a map.

It is commonly asserted that through a well designed, sequential program developed by the classroom teacher the child can acquire a readiness for reading the flat map with all of its seemingly unintelligible symbology. It is clear that the ability to understand symbols, together with all of the other skills necessary for map reading, must be developed through an abundant background of direct concrete experiences before a child is expected to visualize the reality behind the symbols on a map. Experience with reality, three and two-dimensional symbols, and the symbols on a simplified map must lead the child to a level where he ". . . can even think in terms of these symbols."[19]

An analysis of the literature indicates that there is a lack of agreement on the best time to introduce map activities. Davies concluded that "an examination of the findings of . . . several researchers indicates little evidence as to the appropriate grade level to begin instruction about the specific geographic concepts of . . . space."[20] The appropriate time for introducing activities that will result in map reading

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[19] G. F. Davies, "Map Skills and Understanding in Intermediate School Social Studies" (Unpublished Doctoral dissertation, Stanford University, 1962), p. 118.

[20] Ibid., p. 16.

readiness is placed as early as age five and as late as age nine. Witucki[21] and Mitchell[22] feel that a definitely planned program in geography is desirable for children at kindergarten. Through experiences in art and play activities children have opportunities for placing objects in perspective. Children should also be oriented to space concepts such as direction, distance in such broad categories as near and far, and size as in large and small. Both of the writers agree that map readiness activities must carry on through the primary grades. Barton[23] has suggested that if children are given opportunities to draw around the base of objects such as crayon boxes or drinking cups they learn symbolization and are able at age seven or eight to draw diagrams of their own classroom. Moore[24] reported that, given proper readiness experiences, pupils by the end of grade two are able to represent reality in two dimensions.

Yet from her work with children, Shyrock[25] concluded that all map-work except that of the simplest kind should be deferred until the fourth grade. She felt that one of the main causes of poor map reading ability was thrusting maps upon the children before they had built up concepts of

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[21]Lillian G. Witucki, "Map Reading Skills," Social Studies in Elementary School, John U. Michaelis, editor (Thirty-second Yearbook of the National Council for the Social Studies, Washington: NCSS, 1962), pp. 196-205.

[22]Mitchell, op. cit.

[23]Barton, op. cit.

[24]Moore, op. cit.

[25]Clara M. Shyrock, "Gradations in Map Learning," The Journal of Geography, XXXVIII (1939), pp. 181-187.

the physical and cultural features to be represented by symbols. Garnett[26] also suggested that no work with maps should begin until children have reached the age when an understanding of large scale maps comes readily and naturally. She suggested postponement of map work until children are at least eight or even older.

Kohn[27] has been somewhat cautious in placing age or grade levels on the various skills. He suggested that, "Instruction in the use of maps and globes, . . . should be given at the time when children are called upon to consult a map for some specific purpose." However, he further suggested that the groundwork for map reading must be laid throughout the elementary grades as part of the on-going activities of the classroom. He indicated that the ability (intelligence) and experience of particular students account for wide variations in the readiness of the students to represent reality by the use of symbols and to visualize the reality that each symbol represents.

II. RESEARCH RELATED TO MAP SYMBOLIZATION

McAulay conducted a study of map reading abilities of grade two children. The children used for the study had undertaken no previous map work. They were given picture maps to be used to help them solve problems that the teacher read to them. He concluded, among other things, that

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[26] Garnett, op. cit.

[27] Kohn, op. cit., p. 146.

grade two children are capable of using maps to secure information about the local community as well as, ". . . the more extended, wider, unknown, and contrasting physical environment."[28] He further concluded that second grade children are able to visualize through a map an environment different from that with which they are familar. These conclusions indicate that the second grade children studied were able to visualize the reality which the picture map symbols represent.

McAulay recognized that there were weaknesses in the study. He was aware that the picture maps used for the study may have been too simple and that the questions asked may not have been adequately precise. In addition the children studied were all from middle and upper socio-economic homes. A wider range in background of the children, more difficult picture maps, and more precise questioning may have changed the conclusions somewhat.

Rushdooney[29] reported a study in which third grade children were taught map reading skills recommended for children in grades four and five. After ninety minutes of advanced instruction per week for fifteen weeks a test battery was administered. It was found that third grade children could learn many of the map reading skills commonly taught in grades four and five. Further, Rushdooney found a high, linear relationship between map reading achievement and intelligence.

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[28] J. D. McAulay, "Some Map Abilities of Second Grade Children," The Journal of Geography, LXI (January, 1962), p. 9.

[29] Haig A. Rushdooney, "Achievement in Map Reading: An Experimental Study," The Elementary School Journal, LXIV (1963), pp. 70-75.

Sorohan[30] reviewed the literature dealing with map reading to determine the map reading skills to be taught to the intermediate grades. He made lesson plans to teach each skill at grades four to six. After teaching the skills, he evaluated the effect of teaching and determined grade placement according to the mental ages of the children who mastered each skill. Mastery was achieved by having an eighty percent correct response to each item. Using his procedures, Sorohan found that a mental age of at least 131 months is required to master map symbols and a map legend.

Thorp[31] examined students who acquired various geographic tools only through incidental teaching. She found that children in grades four to eight were not able to use such tools as map legend, scale, and location. Thorp concluded that a sequential teaching program was required to equip students with necessary map reading skills.

Satterly[32] conducted a study to identify some of the common problems

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[30]Lawrence J. Sorohan, "The Grade Placement of Map Skills According to the Mental Ages of Elementary School Children". (Unpublished Ph. D. dissertation, Ohio University, 1962).

[31]Mary T. Thorp, "Studies of the Ability of Pupils in Grades Four to Eight to Use Geographic Tools," The Teaching of Geography, G. W. Whipple, editor (The Thirty-Second Yearbook of the National Society for the Study of Education. Bloomington: Public School Publishing Company, 1933), pp. 494-506.

[32]David J. Satterly, "Skills and Concepts Involved in Map Drawing and Map Interpretation," The New Era in Home and School, XLV (November, 1964), pp. 260-263.

faced by children in drawing maps and to identify the skills and concepts on which the drawing and reading of maps depends. In a preliminary study of the mapwork done by primary and secondary school pupils in Cambridge, he found that many children have special difficulties. Satterly found that maps drawn by children show difficulty in spacing of the objects in relation to one another. Sometimes left and right are confused and errors of spatial arrangement and proportion are present. Maps are often drawn showing buildings in elevation. He found that although secondary pupils learn signs and symbols quickly, they are often confused by those which are similar in shape. Another task which presented great difficulty was that of orientation of matching details of a landscape with the map. This task involved, in addition to the ability to recognize land forms, the ability to use clues of spatial arrangement and proportionality which were presented from the two viewpoints.

Using the findings of the preliminary study together with conceptual, spatial, and perceptual variables outlined in writings of Piaget and Thurstone, Satterly administered a test battery to 60 pupils of ages 14 and 15. The test battery included tasks dealing with the conceptual, spatial, and perceptual variables as well as a number of tests of map work performance, one of which was a test of map drawing ability. Intercorrelations between the psychological variables and the map work performance variables indicated that every map work variable was significantly correlated at the .01 level with at least two of the psychological variables. Satterly also found that the best predictor of map work skill was provided by performance on one

of the perceptual variables, that of the perception of embedded figures.

Satterly concluded that the major factor underlying success in map work is perceptual ability. Of major importance is the level of attainment of space concept. Satterly concluded that, because the work of the fifteen year old children in his sample exhibited errors characteristic of earlier stages of development, "Some doubt must be cast on the value of mapwork in the junior school and in early classes of the secondary school." He suggested that only very simple maps should be used to provide material for development of the basic concepts.

Prior conducted a study to discover the connection between mental age, and the ability to understand maps in order to arrive at a suggested age placement for the introduction of maps and atlases. She administered a battery of six tests to a sample of 250 junior shcool classes in Britain. The first two tests were the Raven's Progressive Matrices and the Cornwell Verbal Intelligence Test. The remaining four tests required the children to draw maps of model villages, both full size and half size, to locate various places on a map of the school area, and to locate six cities on a map of England.

Prior concluded, among other things, that ". . . it appears that children are not ready to understand and begin to interpret maps until at least 10 years 7 months Mental Age."[33] or a chronological age of approximately ten years three months. She further indicated that results of the

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[33]F. M. Prior, "The Place of Maps in the Junior School" (unpublished dissertation, University of Birmingham, England, 1959), p. XV.

map drawing tests showed that none of the children produced "a truly diagrammatic layout" even though some of the children had mental ages of twelve years six months and over. Many of the children drew buildings in perspective or elevation rather than in plan regardless of the position from which they viewed the model. She concluded that true understanding of maps could not be expected in the Junior School (ages nine to eleven).

Prior's study must be accepted with some reservation. The entire body of the report is a mere sixteen pages. Description of the sample, the tests, the testing situation, and the analyses are incomplete and unclear. However, despite its limitations, the study contributes a mental age figure to compare with Sorohan's finding as well as confirmation of the difficulties children have in drawing maps.

Towler[34], using the same sample of children used in this investigation, conducted a study of four spatial concepts considered to be necessary to map reading and interpretation. He investigated the concepts of a reference system, distance, direction, and scale. In addition he investigated the relationship between the development of each of the concepts and sex, socio-economic status, chronological age, intelligence, and grade level. Towler developed a battery of five task-type tests, each designed to measure a particular concept, and administered them to a sample of one hundred twenty children in grades one to six inclusive.

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[34] J. O. Towler, "Spatial Concepts of Elementary School Children" (Unpublished Master's thesis, The University of Alberta, Edmonton, 1965).

Several of Towler's numerous findings are relevant to this study. He found there was no significant correlation between each of the variables of sex and socio-economic status and each of the four concepts under study. He did find a significant correlation between each of the variables of chronological age, grade level, and intelligence and each of the four concepts under study with one exception. There was no significant correlation between intelligence and the concept of distance as measured by the test used by Towler. Pertinent to this study is Towler's finding that many of the children made mirror images of the patterns that they were to copy. While mirror images were most prevalent at the lower grades, he found that by the sixth grade level this phenomenon had almost entirely disappeared. He also found that the acquisition of the concept of scale occurred rather suddenly at the grade five and six levels. Up to the end of the fourth grade, children rarely considered both dimensions even though they had an awareness of the concept.

Sheridan[35] investigated the awareness beginning first grade children have of concepts of physical geography. The method used in the investigation and two of the findings are pertinent to this study. The test instrument was divided into two parts, the oral test and the picture test. The picture test was designed to measure each child's ability to identify pictures of each concept. Discrimination was required to select the four right pictures from the eight used to represent each concept. Sheridan

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[35] Jack M. Sheridan, "An Investigation of Beginning First Grade Children's Awareness Regarding a Selected Number of Concepts of Physical Geography," Dissertation Abstracts, XXV (April, 1965), pp. 5649-5650.

found that boys scored significantly higher than girls on both oral and picture test. He also found a relationship between the scores of children on an intelligence test and their scores on each of the oral picture tests.

III. PSYCHOLOGICAL INVESTIGATION RELATED TO MAP DRAWING AND MAP READING

Any discussion of psychological studies relevant to map drawing and map reading must be preceded by a discussion of the terms "concept" and "concept formation." Thomson suggested that, "A concept is basically a system of learned responses the purpose of which is to organize and interpret data provided by sense-perception."[36] Concepts, usually associated with words or phrases, are used to apply past experience to present situations.

Vinacke reviewed a number of studies dealing with concept formation in children and summarized some of the conditions which are related to it. The first condition related to concept formation in children is age. He stated that, "children's concepts change with increasing age, but more in the form of a gradual progression . . . than of definite stages."[37] Second, intelligence is related to concept formation. From his studies Vinacke concluded that, ". . . psychologists have assumed that intelligence and concept formation are related, although they have not yet worked

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[36]Robert Thomson, The Psychology of Thinking (Baltimore: Penguin Books Inc., 1959), p. 65.

[37]W. E. Vinacke, The Psychology of Thinking (New York: McGraw-Hill Book Co., 1952), p. 119.

out the relationship explicitly."[38] Vinacke further suggested that some studies have indicated that chronological age is at least as important as mental age. A third condition related to concept formation is training or experience. Children may differ in their concepts because of their variations in experience. Fourth, socio-economic status has only a very low relation to scores on concept tests. Finally, vocabulary has been shown to be a substantial factor in concept development. Vinacke summer up the psychological viewpoint on concept formation by saying:

> Research shows that children's concepts undergo long and continuous development. In addition to the readily observed increase in the number and complexity of concept systems, it is probable that they gradually change from naive, prelogical, egocentric forms to more mature, logical, objective forms.[39]

The psychological viewpoint of concept formation in children has probably been best developed by Jean Piaget[40], who together with Barbel Inhelder advanced a comprehensive theory of the child's concept of space. The major emphasis of their study was on the child's development of representational space rather than perceptual space. It was found by Piaget that as early as six months of age a child can distinguish between a circle and a triangle when they are visually presented, but it is much later before he can represent the figures to himself in thought. Piaget was primarily concerned with intellectual development as it works on spatial relationships. He further emphasized that spatial representations

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[38] Ibid.

[39] Ibid., p. 120.

[40] Jean Piaget and Barbel Inhelder, The Child's Conception of Space (London: Routledge and Kegan Paul, 1963).

are built up through the organizations of actions performed on objects in space. At first the actions are motor but later they are internalized actions. An adult, for example, "sees" objects in space because in the past he has performed actions of placing objects together and separating them. Piaget hypothesized that topological relations appear first in the child. These are followed by projective and Euclidean relations. In topological space, the most general, primitive relationships such as proximity, order, closure, and continuity are included. In projective space, objects are located relative to one another although there is no measurement. This concept is developed when the child considers an object in relation to "a point of view." A child can visualize what objects would look like from different positions. In Euclidean space, objects are located by means of an exis of reference such as length, breadth, and height and the child can use measurement. Piaget conducted a number of interesting and ingenious experiments in order to test the hypothesis outlined above.

The validity of the "topological-primacy" hypothesis has been questioned by Fisher and Gracey. These investigators suggested that the acquisition of language at various rates may partly account for the child's ability to identify shape impressions in terms of categories which are meaningful to them. Further, they suggested that because fewer words are available to the child to classify linear than topological shapes, the "topological-primary" hypothesis needs to be replaced by one of "linear primacy."[41]

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[41]Gerald H. Fisher and Sheila Gracey, "Developmental Features of Visual and Tactile Kinaesthetic Shape Perception," (paper read at the British Psychological Society Annual Conference, 1963).

Before discussing the experiments that are relevant to this study, it is necessary to summarize Piaget's theory of cognitive development. Piaget outlined four major stages in the development of mental structures. Each stage is divided into several substages. Stage 1, developed from birth to age two, is described as the sensori-motor period. The motor activities of this stage are not yet capable of being internalized into mental representations. By the end of this period the child is able to appreciate the permanence and stability of objects.

The second stage, the pre-operational level, is divided into two phases. The first phase from age 2 to 4 years is the transductive phase which is characterized by symbolic function such as symbolic play and language. However, reasoning is irreversible, lacks generality, and is tied to action. In the intuitive phase, age 4 to 7 years, proper thought begins to appear. The child's understanding that operations are reversible is still unstable. His egocentrism makes it almost impossible for the child to distinguish between himself and the object. Some conceptual activity is present but it is still tied to perceptual appearances.

The third stage, the period of concrete operations from 7 to 11 years of age, is characterized by the acquiring by the child of certain basic concepts organized into stable structures. About 7 to 8 the child is able to formulate the concept of a logical class which is the result of internalization of action grouping of objects. Asymmetrical relations are developed as the result of internalization of the action of ordering. Number concepts can also be understood. Thought at the concrete operations stage is no longer egocentric and can deal with the rearrangement of objects, especially

at the active level. However, the concepts are still not generalized to all situations.

In the final stage, the formal operational level beginning at the age of 11 or 12, perception and action are replaced by the formal abstract thought. A complete reversibility of thought is characteristic of this stage. The child is fully capable of reflective thought and logical experiments.

In the first experiment relevant to this study a pasteboard model was made to represent three mountains. From his position in front of the model, the child saw a green mountain in the right foreground, a larger brown one to the left middle, and a tall grey pyramid in the background. The child was shown ten pictures representing the mountains from different viewpoints painted the same color as the model. A doll was placed in a number of different positions and the child's task was to discover what perspective the doll would "see" in each position. Three pieces of cardboard colored and shaped to represent the base of the mountains were also used.

Three separate methods of questioning were employed. The first required the child to produce a lay-out of three pieces of cardboard to represent the kind of picture the doll could take from various positions. Next the child was to pick out the one of the ten pictures which best suited the view seen by the doll. The third was the converse of the second. The child selected a picture and then decided what position the doll would have to occupy to have taken a snapshot similar to it.

Piaget reported that throughout stage II the child distinguishes hardly or not at all between his own viewpoint and that of other observers. The child fails to realize that different observers will enjoy a different perspective and seems to regard his own point of view as the only one possible. At substage IIA the egocentric illusion, or the child's centering his perception on his own viewpoint, explain why the child endows the group of mountains with a false type of shape constancy in method 1. In method 2 the answers are just the opposite. In the third method, the child puts the doll down among the mountains shown in the picture in the perspective as he, not the doll, sees it. At substage IIB the child senses that the viewpoints of others vary from his own. This is the beginning of a transition between the spatial egocentrism of substage IIA and the first signs of true relativity which appear at substage IIIA. The relationships of left-right, before-behind are not yet real to the child. That is to say, they are not yet subject to changes of sequence and reversals dependent upon the observer's position. Relativity is only partially attained. However, this substage is a definite step toward a true relativity for there is some awareness that things will look different to an observer stationed elsewhere.

Stage III (7-8 to 11-12 years) shows a progressive discrimination and coordination of perspectives. At substage IIIA (7-8 to 9 years) the child has discovered that the left-right, before-behind relations between the mountains vary according to the position of the observer. A partial relativity is achieved for the child takes account of only one relationship.

During substage IIIB, it was found to be easier to construct a scene by means of three cardboard cut-outs than to choose from the pictures of the mountains. The correspondence between the observer's position and the projective relationship has become point to point and is conceptual in character.

A second experiment which is relevant to this study consisted of looking at objects made of plasticine such as a cylinder, a prism, or a cone. The child was asked to predict the shape of the surface produced when the solid was cut along various planes with a large knife. The child was asked to draw the expected surface and pick it out from comparison drawings.

General results indicate that at stage I the different surfaces are not yet distinguished and from one another. At substage IIA (about 4 to 5-1/2 or 6 years) the child is unable to show the section for he cannot distinguish the internal viewpoint which represents the section of the object. The child cannot select the appropriate drawing from the samples. At substage IIB (5-1/2 or 6-7 or 8 years) the sectional surface is gradually distinguished from the intact shape. By stage III this achievement is consolidated in operational form. It is necessary for the child to create an imaginary projection. Piaget said that

> . . . the problem of imagining sectional surfaces constitutes a clear case of shape abstraction . . . this abstraction is one based wholly on the actions of the subject, for it entails not only the coming into play of two types of operations--one related to objects and the other to points of view--but also the establishment of correspondence between these two types of action or operation.[42]

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[42]Piaget, op. cit., pp. 269-270.

In a third experiment relevant to this study, Piaget asked the children to draw a man with a horse and cart to find out whether they would "rotate" into the horizontal plane various parts of the drawing or whether they could confine themselves to a single viewpoint. Children were also shown solids such as a cylinder, a cube, and a cone and asked to draw them opened out flat.

Stage I (below 4) cannot be studied. Stage II is defined by either total or partial inability to discriminate between different viewpoints. At substage IIA drawings of the solid folded cannot be distinguished from drawings of it opened out. The body of the cart is drawn in plane, the horse in profile, and the wheels are turned to the same plane as the body. Substage IIB reveals the beginning of a discrimination between the intact and the developed solid. Motor activity is still the key action. Stage III is marked by the discovery of true rotation. At substage IIIA (7-9 years) the child is able to perform a mental action and to coordinate the different points of view to pass from perception of the intact solid to an image or drawing. At substage IIIB the child is able to visualize the solid in three dimensions and pass from one point of view to another in order to project the surfaces on to the same plane.

In another experiment, Piaget asked each child to place a doll on his model landscape in exactly the same position as that of a similar doll on the original model. The second model is turned through 180 degrees so that the child is forced to coordinate the projective "points of view" as well as the Euclidean relationships.

Throughout stage I (up to 3:6 - 4 years) the position of the doll is determined by its relative proximity or the immediate surroundings. During substage IIA the child locates the doll relative to his own position and disregards the reversal of the landscape of his model. The child begins to coordinate the relative positions of a number of items and left-right, before-behind relations influence his placement. Substage IIB has children being able to take into account the effects of rotation, though only step by step. From the beginning of substage IIIA the rotation of the model does not have any effect on the child's judgment. The dual system of reference provided by the two dimensions of the model is used.

The last experiment relevant to this study involved drawing a map of a model village comprising a few cottages, a church, trees and so on. In addition, all subjects placed objects relative to one another without rotation of the base.

Children up to age 4 (stage I) are not able to achieve spatial or one to one correspondence between the objects. The objects are usually bunched together or strung out in a straight line. During stage II (from 4 to 6-7 years) the child is able to choose pieces which correspond to the objects in the model. He is unable to locate them according to a system of reference because he hasn't the relationship of distance and order. Objects are usually located around a single object used as a point of reference. During stage III (7-10 years) the child gradually uses a system of reference beginning with left-right orientation, followed by that of before-behind, with distance only partly taken into account. By stage IV

the concept of a diagrammatic layout is acquired in a broad and general way. The child can locate the objects in a formal or abstract design.

In stage I, the map drawings generally show the item in the model in a linear series. In stage II (ages 4-7) the children have no system of reference for locating objects and find it difficult to spread out the objects over all the space. Some children make use of the relations between left and right viewpoints but reverse them unwittingly. The before-behind relations are hinted at but cannot be expressed in the drawings. By stage III (age 7-9) the child is able to arrange items according to the two dimensions of the model. Right-left, behind-before relations are now immediate. Buildings are shown in elevation. Distances cannot be gauged accurately and scale is not consistent. By substage IIIB distances are more carefully judged and drawings can be reduced to scale. A purely schematic plan drawn by exact measurement is produced at stage IV. A transfer from physical to abstract co-ordinates is apparent. Thus by age 11 or 12 the child exhibits a combination of individually worked out and formally learned concepts which enables him to understand maps.

Piaget, through the manipulative tasks, observation, and interview which makes up his clinical approach, suggested that children pass through a number of recognizable stages at various ages. Spatial concepts are attained by internalized actions over a period of years. While his work is probably the most interesting and comprehensive in the field of conceptual development in children it has also received considerable criticism. First, no clear standardized test procedure is outlined. There

are often no details regarding the exact nature of the apparatus used, the questions asked, the data obtained, or the treatment of the data. Second, Piaget rarely indicates the number, background, and intelligence of the children he has tested. It often appears as though only a very few children of rather superior intelligence have been tested. Piaget has combined his highly systematic theory with the results of careful observations of his experiments with children so that empirical contents and abstract theory need to be sorted out in readings.

Various aspects of Piaget's work on the spatical concepts of children have been replicated by researchers such as Lovell[43], Peel[44], Prior[45], Satterly[46], Towler[47], and others. Some of their findings agree with those of Piaget and some do not. These researchers have generally found the stages at which children have acquired a specific concept to agree with those of Piaget. If they did not agree, they were found to have developed at a later stage than suggested by Piaget. More experimental evidence is necessary before Piaget's work can be accepted in its entirety.

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[43]K. Lovell, "A Follow-Up Study of Some Aspects of the Work of Piaget and Inhelder on the Child's Conception of Space," British Journal of Educational Psychology, XXIX (June, 1959), pp. 104-117.

[44]E. A. Peel, "Experimental Examination of Some of Piaget's Schemata Concerning Children's Perception and Thinking, and a Discussion of Their Educational Significance", Ibid., XXIX (June, 1959), pp. 89-103.

[45]Prior, op. cit.

[46]Satterly, op. cit.

[47]Towler, op. cit.

IV. DISCUSSION AND SUMMARY

An abundance of material has been written about the need for teaching map reading skills. It would appear that certain basic map skills are necessary in order to read a map. Most writers agree that the skills deemed necessary to map reading need be taught in a definite sequence. However, there is some disagreement as to what that sequence is and when it should be taught.

Research studies in map reading have generally been confined to surveys of the literature and existing curricula in an effort to refine the basic skills necessary to read a map. The researchers then have attempted to develop a sequential program for teaching the skills. A few studies have investigated and attempted to place map concepts and skills at definite grade levels in terms of the ability to learn and use them effectively. However, these studies have generally been global in nature, attempting to investigate most or all of the skills and concepts which have been outlined as being pertinent to map reading. None of the studies reviewed in the previous section attempted to investigate one concept in depth in order to more fully understand the nature of its development in children. The study conducted by Piaget and Inhelder appears to be the most comprehensive investigation of the development of spatial concepts of children. Some of Piaget's work has been replicated but as yet the knowledge of when and how spatical concepts develop is far from complete. Much more classroom experimentation and research is required in this area.

This study was designed to investigate one aspect of map reading which, in the past, has generally been investigated as part of a global study of map reading. The comprehension of map symbols is probably the most important aspect of map reading and interpretation. This study seeks to determine how and when the comprehension of map symbols develops in children and whether such factors as sex, socio-economic status, age, grade level, and intelligence, reportedly related to concept development, have any influence on its development.

CHAPTER III

DESIGN OF THE EXPERIMENT

This chapter is devoted to an explanation of the selection of the sample, a description of the tests administered, and an outline of the statistical procedures employed in the analyses of the data.

I. POPULATION AND SAMPLE

The population consisted of all children in grades one to six inclusive in attendance at three schools of the Edmonton Public School System. One of the three schools was used for the pilot study. Enrollment at the two schools used for the main investigation totalled approximately one hundred fifty students at each grade level. The two schools were selected for a number of reasons. First, these schools were able to provide adequate accommodation for individual testing with a minimum of interruption. Second, the two schools had not placed any special emphasis on a map reading program. It was felt by the researcher, after consultation with the principal of each school, that these schools were fairly representative of a normal program in the social studies in the City of Edmonton. Third, the effect of socio-economic status was to be studied, so the researcher chose one school in a recently developed area of the city where residents were of fairly high socio-economic status and one school in an older area where the socio-economic status of the residents was generally much lower. This selection was

designed to ensure a fairly wide range of socio-economic background.

The samples for the pilot study and the main investigation were selected by the following method. In each school, boys and girls at each grade one through six were given a number. A table of random numbers[1] was used to select five males and five females at each grade level at each of the two schools. Thus the total sample of 120 consisted of ten males and ten females at each grade from one to six inclusive. The same procedure was used to select the sample of twelve consisting of one male and one female at each grade from one to six for the pilot study. A letter (see Appendix A) describing the purpose of the study was sent to the parents of each child in the sample. No objections were received from any of the parents so the entire sample of one hundred twenty was tested.

Two types of pupils were excluded from the population. Pupils who had been accelerated or who had repeated a grade were not included. In addition, pupils who were recent immigrants were excluded. It was felt that these pupils would have been at a disadvantage if language problems made it difficult to understand oral test instructions and/or take the written test.

II. THE INSTRUMENT

Two separate testing situations were established for each sub-

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[1]Herbert Arkin and Raymond Cotton, Tables for Statisticians (New York: Barnes and Noble, Inc., 1950), pp. 142-145

ject. First, the non-verbal Lorge-Thorndike Intelligence Test, form B was administered to the sample at each school in group situations. The appropriate level was administered to the subjects in each grade. The items on the non-verbal battery, pictorial, diagrammatic, or numerical, comprise a test of abstract intelligence defined as "...the ability to work with ideas and the relationships among ideas".[2] Level 1 used at grade one and level 2 used at grades two and three each had sections dealing with oral vocabulary, cross-out, and pairing. In the first two sections, the subjects were required to circle one of four or five pictures in each row in response to oral directions by the examiner. The pairing section required the subject to circle two of the five pictures in each row which were related. Level 3, used with grades four to six, had subtests dealing with figure analogies, figure classification and number series. The subject was required to circle the correct response. Time limits were imposed on level 3.

The tests were scored by use of the scoring key provided. The intelligence quotient of each subject was determined by using a table presented in the examiner's manual.

Over 136,000 children were tested for standardization of the test. Evidence of reliability of the test were presented in a number of ways. The alternate forms correlated from .761 to .814 at the three

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[2] Irving Lorge and R.L. Thorndike, The Lorge-Thorndike Intelligence Tests, Technical Manual (Boston: Houghton, Mifflin Co., 1957), p. 2

levels. The standard errors of measurement of the tests used varied from 6.2 to 7.8 points. Validity of the test was established in a number of ways. The correlations between the non-verbal forms of the Lorge-Thorndike Intelligence Tests and the California Mental Maturity, Kuhlmann-Anderson, and Otis were listed as .74, .65, and .71 respectively. Frank S. Freeman, in a review published in The Fifth Mental Measurements Yearbook suggested:

> This 1957 version of the "Lorge-Thorndike Intelligence Tests" is among the best group tests available, from the point of view of the psychological constructs upon which it is based and that of statistical standardization.[3]

In the second testing situation, the Base Area Symbols Test was administered to each individual. Modifications of some of the tasks used in experiments by Piaget as well as original tasks were included in this test which was designed, administered, and scored by the investigator. A pilot study was conducted with a group of twelve students who did not form part of the sample. Minor revisions in instructions and test items were made before the final testing began. The final form of the task-type test (see Appendix B) consisted of two series of tasks containing five and four items respectively.

The basis for all tasks was a three dimensional model town consisting of four blocks of realistic buildings seen by the subject at the angle shown in Figure 1. The base of the model town, thirty-one inches wide and forty-three inches long, was divided into four

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[3]Oscar K. Buros, The Fifth Mental Measurements Yearbook (New Jersey: The Gryphon Press, 1959), p. 479.

Block 1

Block 2

Block 3

Block 4

Figure 1. Photograph of the model used as the basis of the Base Area Symbols Test

blocks by a street and an avenue cutting each dimension into equal parts. The intersection was characterized by a "square" so each block had a diagonal cut with a building facing the square. The streets were grey, the sidewalks were white, and the blocks were green. No fences, individual sidewalks, or driveways were placed on the blocks for it was felt they would distract from the buildings and would serve as axes for placement of symbols in later tasks. For purposes of identification in this discussion the blocks were numbered from 1 to 4 inclusive in Figure 1. A duplicate base was constructed and was used in tasks I and III of section A and tasks VI, VII, and VIII, of section B. Blocks 1 to 3 each contained four three-dimensional buildings while block 4 had only three buildings and a parking lot housing three realistic automobiles. The dimensions of the buildings in inches were 3 x 3, 3 x 4, 3 x 6, or 3 x 10. The walls of each building were white and the roofs were green, blue, red, or black. A number of model trees was located on each block.

Several of the tasks which comprised the Base Area Symbols Test were unique in design so they could not be correlated with other tests of this type. Some of the tasks were replications of, or patterned after items used by Piaget in his investigations. It has been assumed therefore that the test items measured the concept they were designed to measure, at least to the degree to which Piaget measured it.

Reliability of the Base Area Symbols Test has been established, in part, by determining the internal consistency of the test.[4] Each item has been correlated with every other item, results of which are presented in the following chapter.[5]

The construct validity of the test was established through "... the technique of correlating items with total scores".[6] Using this technique it was assumed that the total score of any individual was valid. Therefore, "To the extent that any item measures the same thing the total score does, to that extent the item is valid".[7] In addition, the examiner has attempted to develop a valid test by selecting variables which may affect test performance, setting up hypotheses based on these variables, and then testing the hypotheses. This was a type of construct validation for Kerlinger has stated that, "In one sense, any type of validation is construct validation. Whenever hypotheses are tested, whenever relations are empirically studied, construct validity is involved".[8]

Tasks in Section A--Transition from Three Dimensional Models to Two Dimensional Symbols

The tasks in section A were designed to measure the subject's

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[4]Fred N. Kerlinger, Foundations of Behaviorial Research (New York: Holt, Rinehart and Winston, Inc.,1964), p. 439

[5]Infra., pp. 106-111.

[6]Kerlinger, op. cit., p. 453

[7]Ibid

[8]Ibid., pp. 451-2

ability to represent the three-dimensional models of the town in two dimensions in the form of a map. The first four tasks involved selection or selection and placement of appropriate symbols while task five required the subject to draw a map of a specified block of the model town. Due to the possibilities that learning during the testing situation might influence performance the tasks of section A and B numbered 1-9 inclusive (see Appendix B) were given to odd numbered subjects in the following order: I, IV, V, II, III, VI, VII, VIII, IX. The even numbered subjects were tested in the following order: I, IV, V, IX, VIII, VII, VI, III, II. Thus, while tasks I, IV and V were given first to each subject in that order so that learning would not alter their performance on map drawing tasks, the remaining tasks were reversed with every other subject so that the effect of learning would be distributed through the tasks. No time limits were placed on any of the tasks in this section.

Photo Identification (Task 1). The first task was designed to determine when a child is able to visualize what objects look like from above, a view which the child was not able to actually see. It would appear that being able to visualize what buildings would look like from above would be vital in order to see the relationship between base area symbols and the reality they represent.

In the first task the apparatus consisted of six photographs of the model town laid out on a table to the left of the model town. Figures 2, 3, 4, 5, 6, and 7 are copies of the six photographs shown

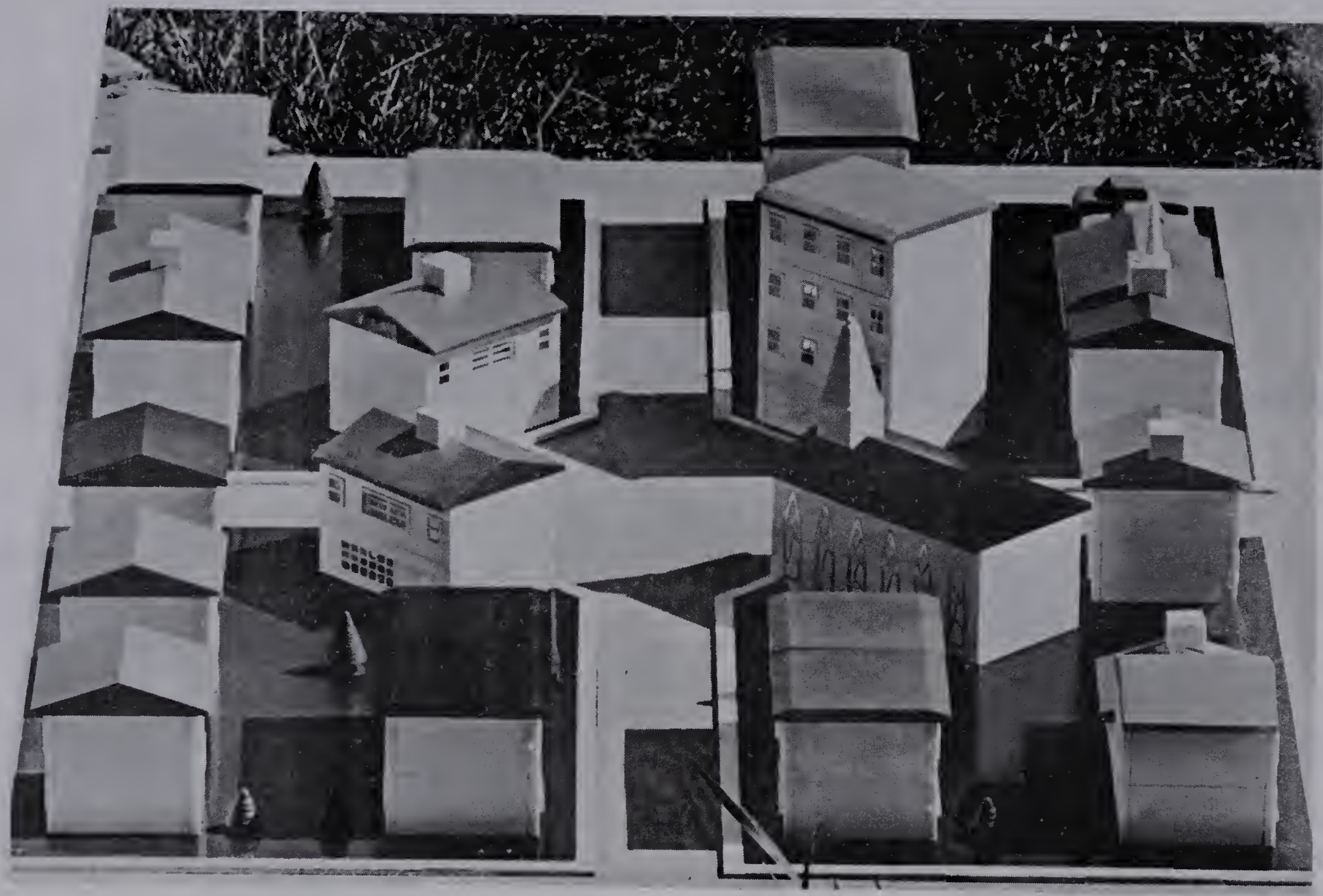


Figure 2. Photograph 1 used for Task I.

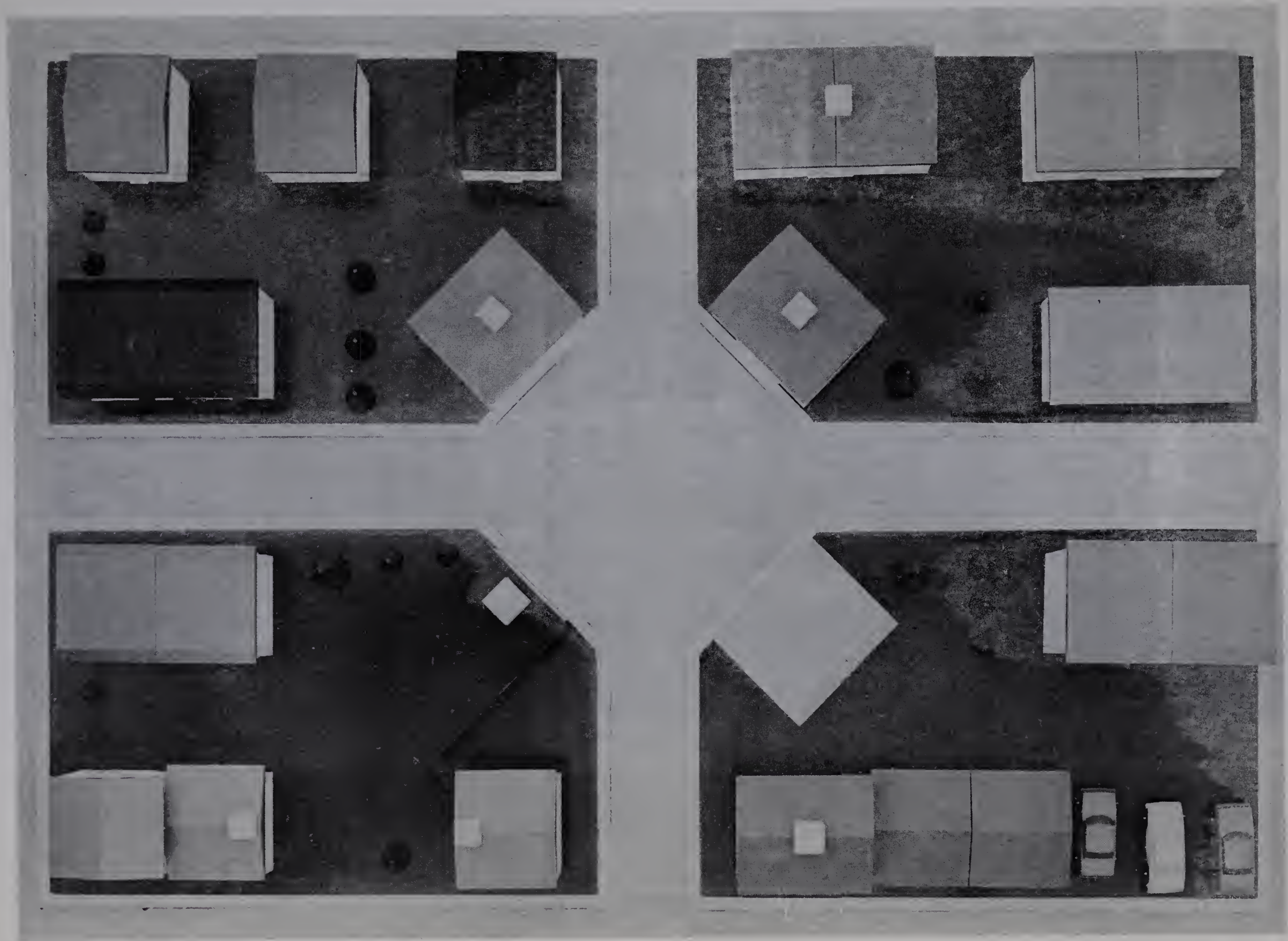


Figure 3. Photograph 2 for Task I.

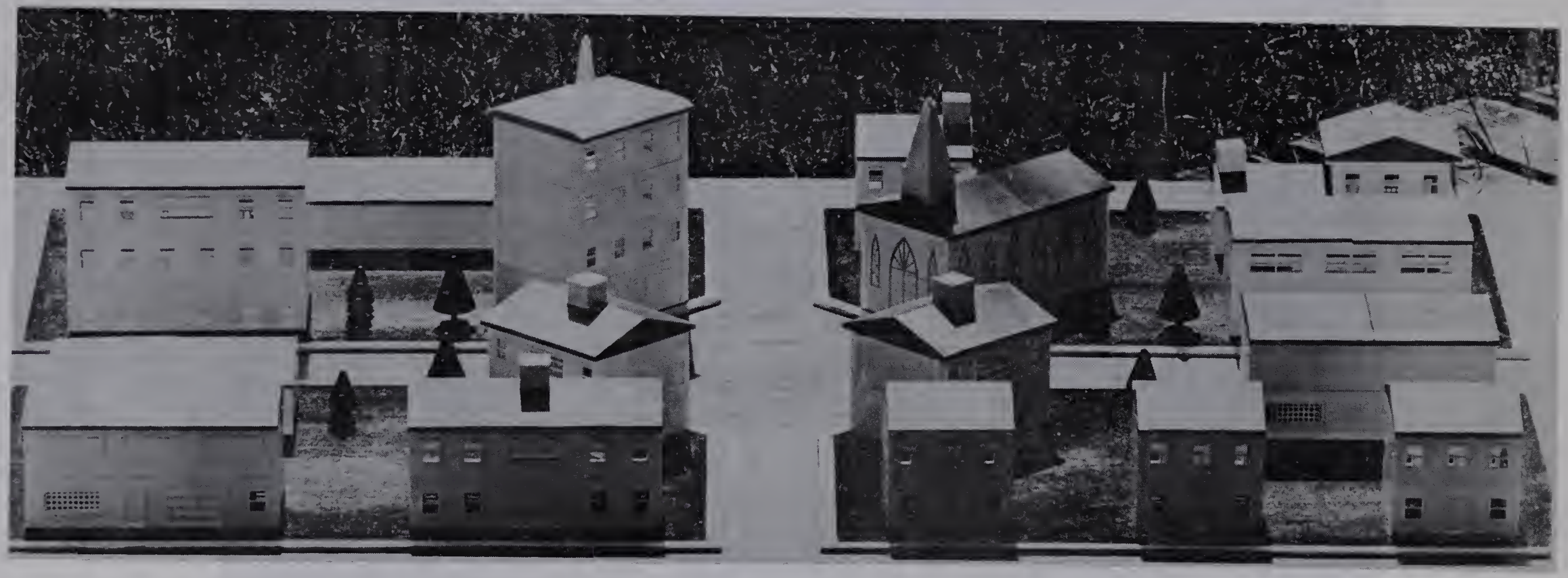


Figure 4. Photograph 3 used for Task I.

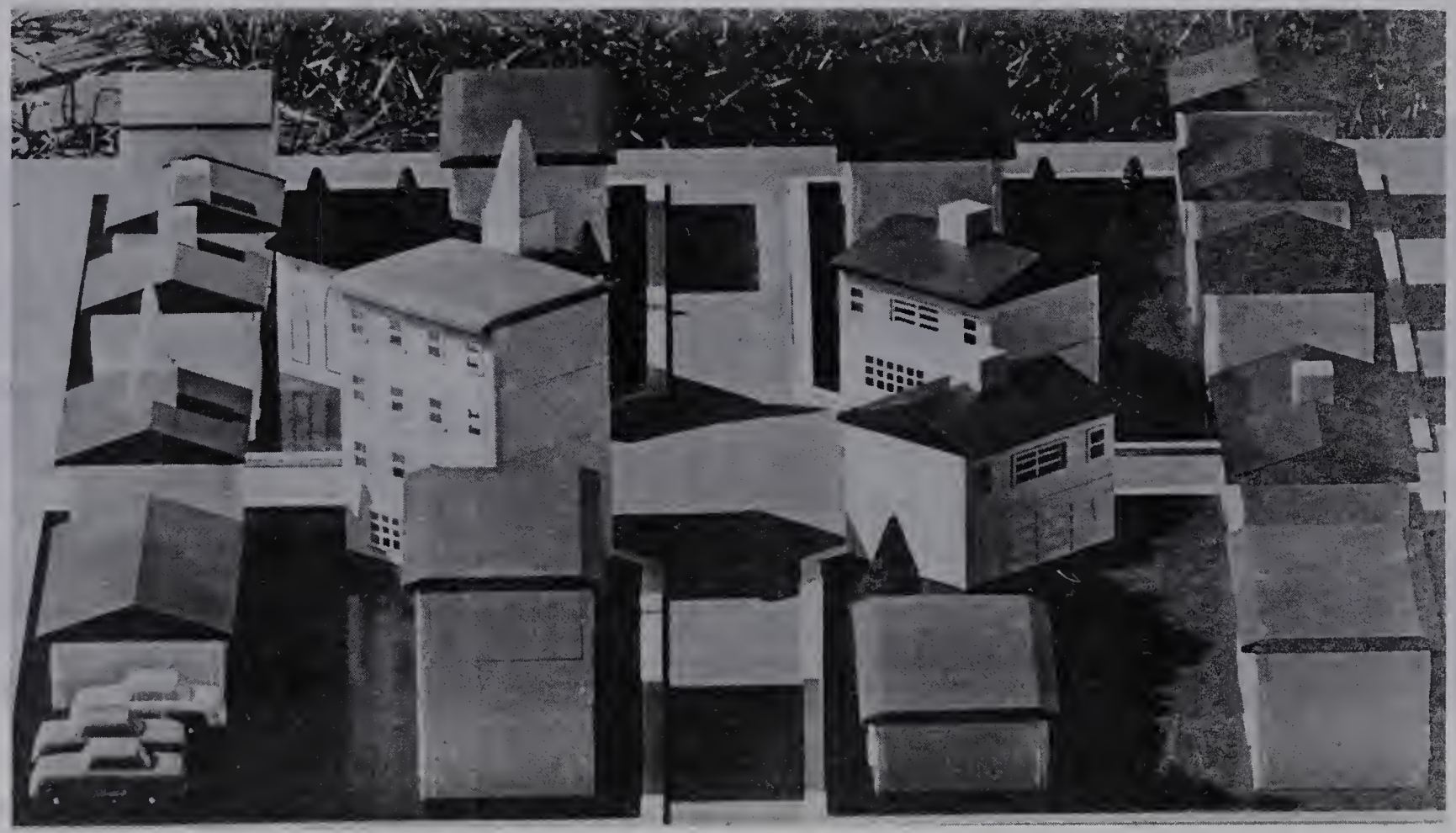


Figure 5. Photograph 4 used for Task I.

Figure 6. Photograph 5 used for Task I.

Figure 7. Photograph 6 used for Task I.

to each subject. Following is a brief description of each photograph.

Figure 2. This photograph was an oblique view taken from left to right (as seen by the subject).

Figure 3. The second photograph showed a vertical view of the town.

Figure 4. This figure showed a view taken from the side opposite to that of the view of the subject.

Figure 5. The fourth photograph was an oblique view taken from right to left as seen from the subject's view.

Figure 6. This photograph was a view which most accurately represented what each subject saw when looking at the model town.

Figure 7. The last photograph was similar to Figure 6 except that the angle was closer to the horizontal.

When the subject entered the testing room he was asked to look carefully at the "little town" at a distance sufficient to allow a view at approximately a 45 degree angle. The subject was not permitted to look at the model town from above at any time. Then the six photographs were laid out on a table to the left of the model and the subject was asked to identify the one photograph which could have been taken by a man flying over the "town" in a helicopter. When the selection was made, the subject was asked why he had chosen the one he did. The reply was recorded on the answer sheet used for each subject. (See Appendix C). The photographs were immediately removed from the table without comment.

Three-Dimensional Symbols (Task II). The task was designed to determine the degree to which the subject could remove himself one step from reality by representing the realistic buildings of the model

by the use of three-dimensional symbols. The symbols, blocks of styrofoam, were to be selected from a group of ten and then placed on a base duplicate of the model town in order to replicate in symbols one block of the model town.

Block 3 remained screened from the remainder of the model. The duplicate base was placed to the left of the model town and the three-dimensional symbols were placed on a small table immediately to the left of the subject.

Two-Dimensional Symbols (Task III). This task was designed to determine the degree to which the subject could represent three-dimensional realistic buildings by the use of two-dimensional symbols made of thin white cardboard. The apparatus and instructions, with the exception of the symbols used, were identical to those of Task II.

Map Selection (Task IV). The task was designed to examine the subject's understanding of a map consisting of base area symbols only as compared with profiles of the same block of the model town. It was suspected that subjects would select profiles closely resembling what they actually saw when looking at the model rather than the purely symbolical map.

The apparatus for this task consisted of block 3 of the model town and five cards. (See Figures 8, 9, 10, 11, and 12). A cardboard screen was placed around block 3 so that the subject would not be distracted by the remainder of the model. Following is a brief description of each of the cards used as part of the apparatus.

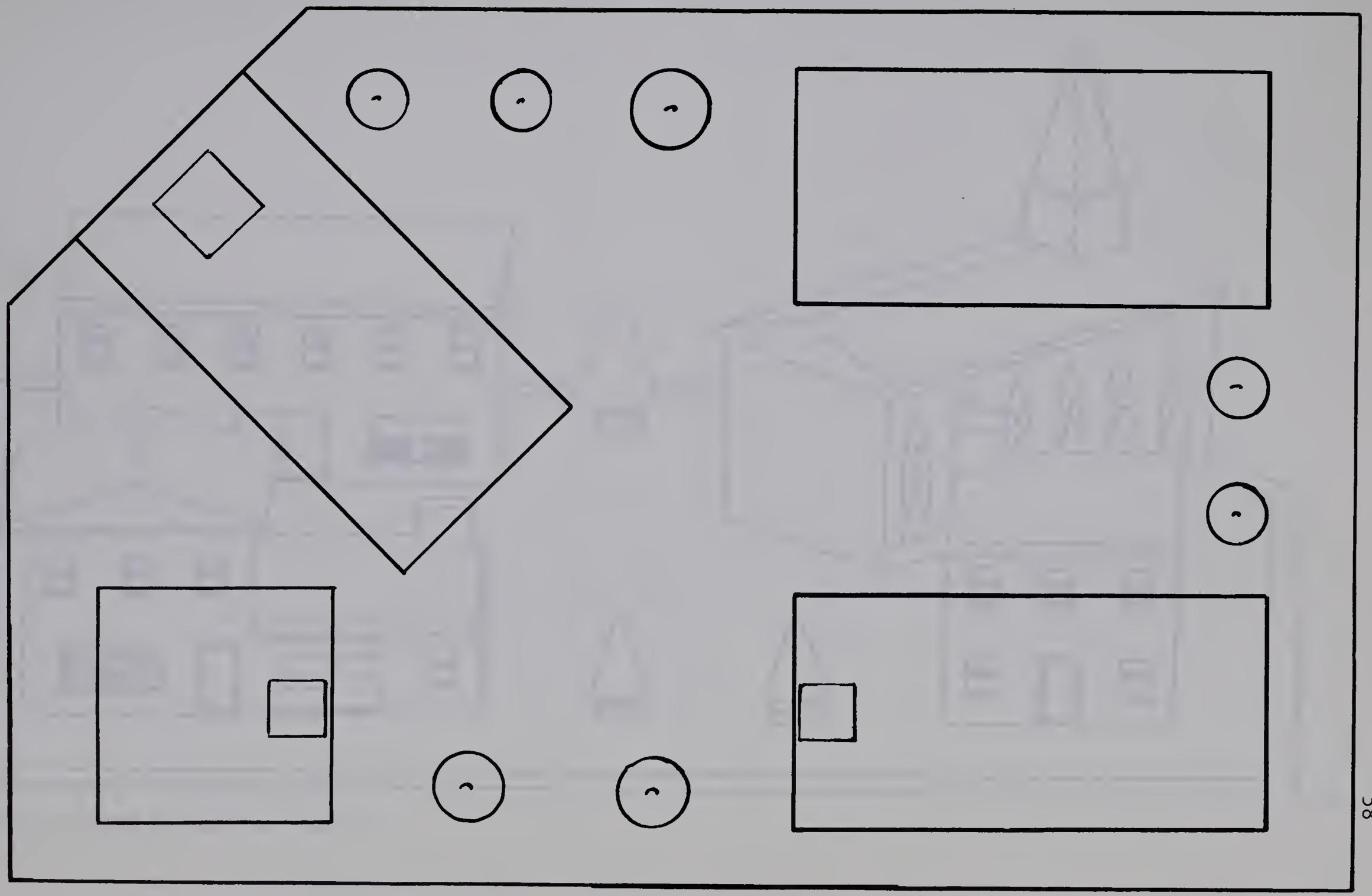
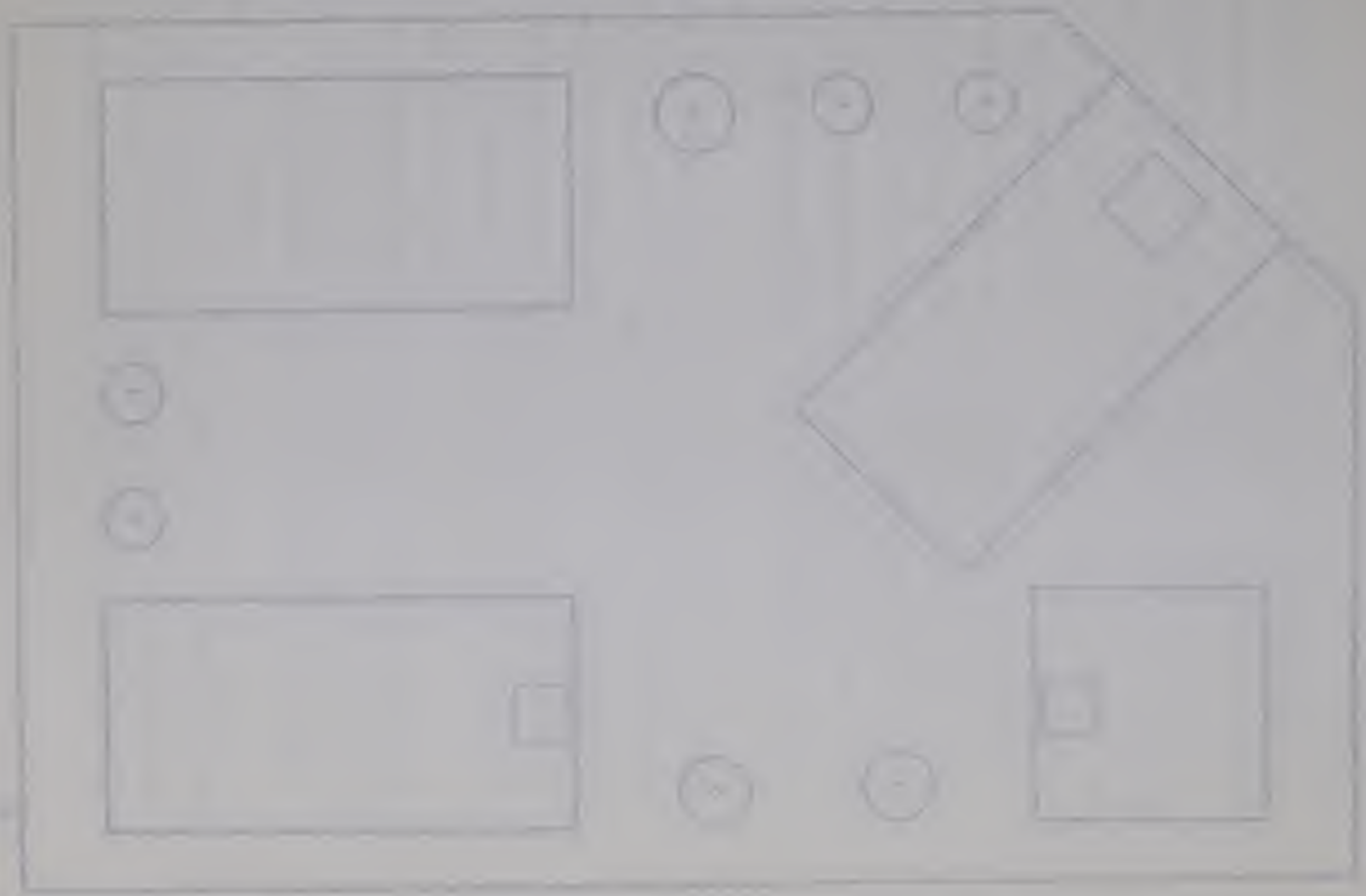


Figure 8. Card 1 used for Task IV.



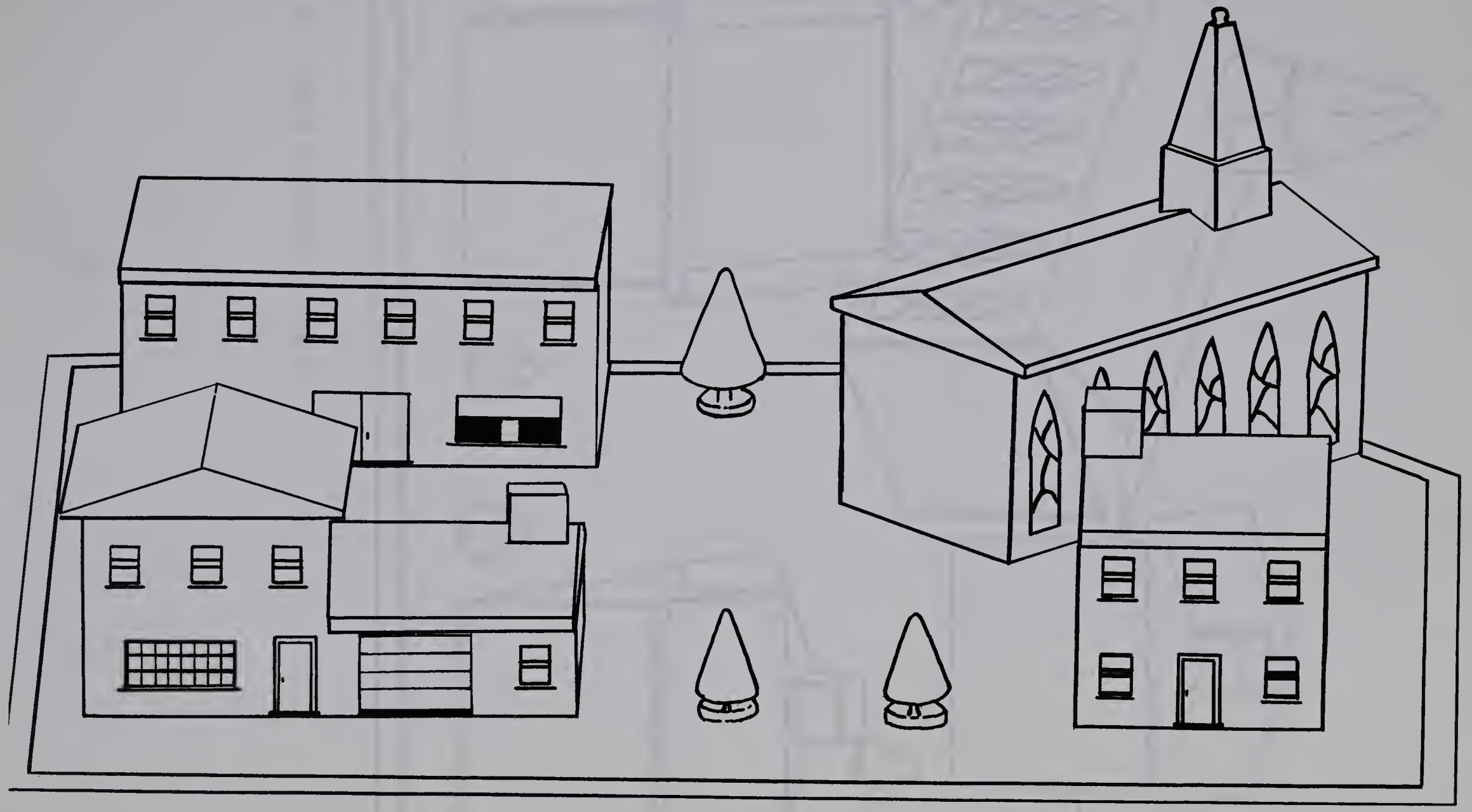


Figure 9. Card 2 used for Task IV.

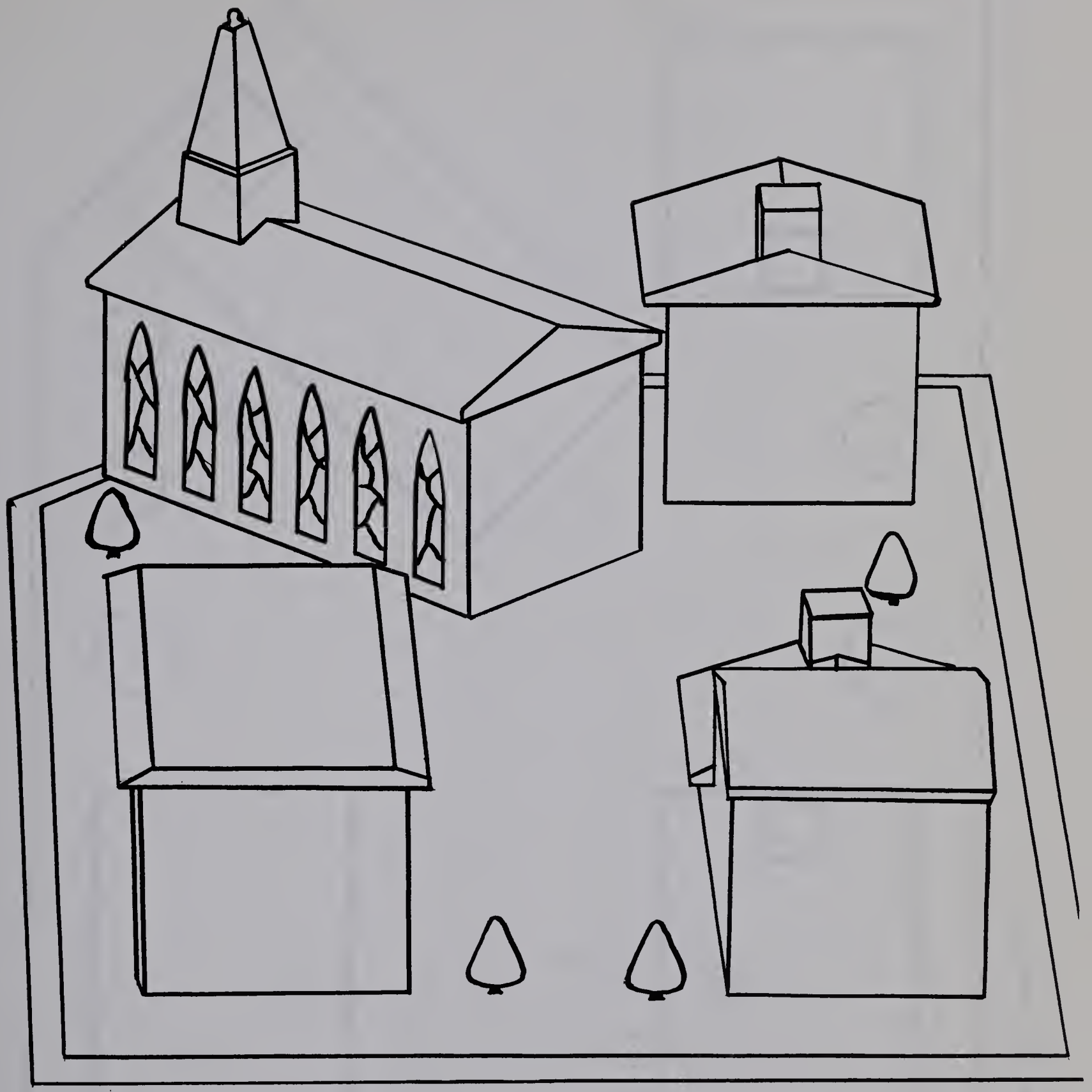


Figure 10. Card 3 used for Task IV.

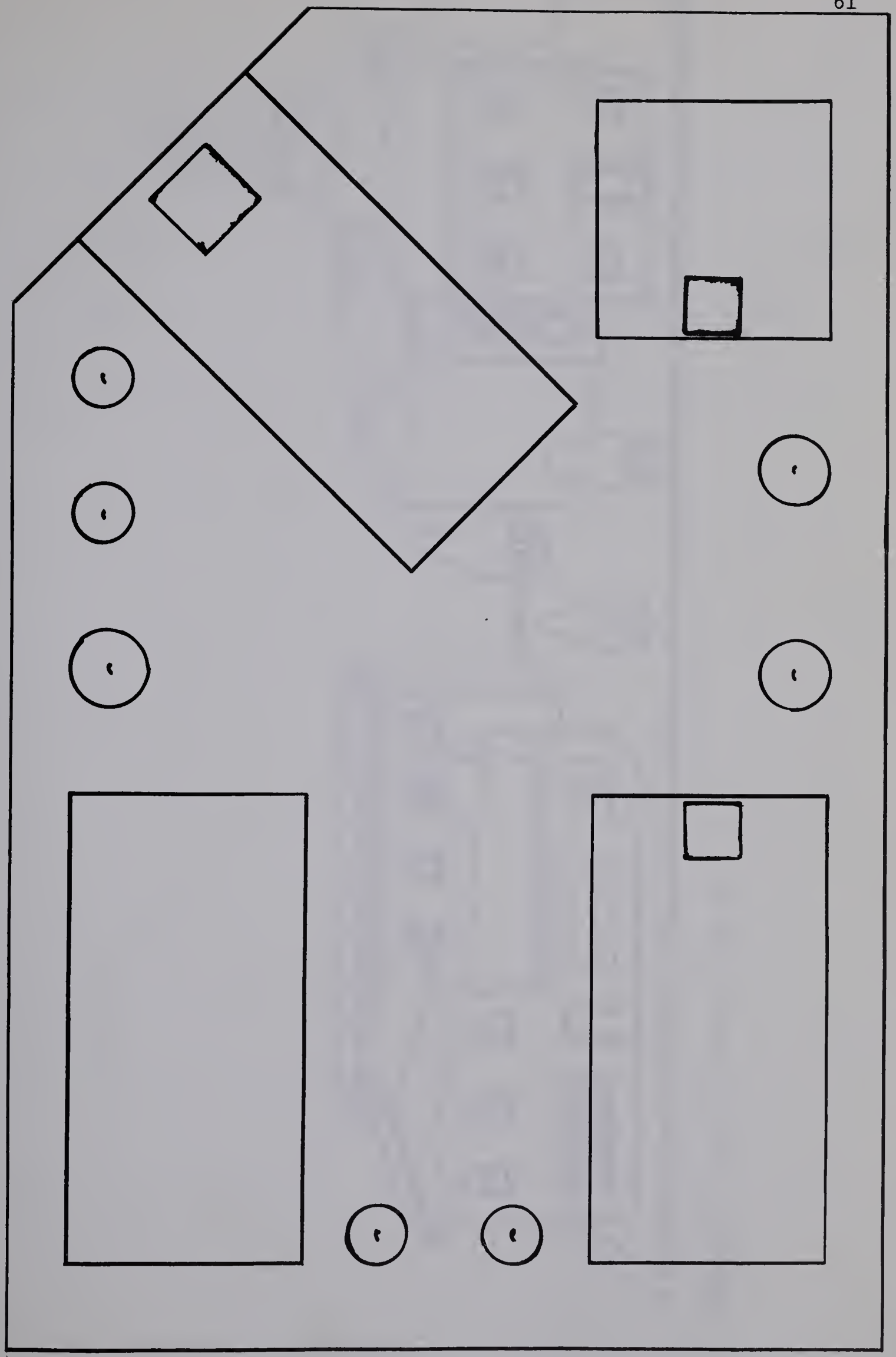


Figure 11. Card 4 used for Task IV.

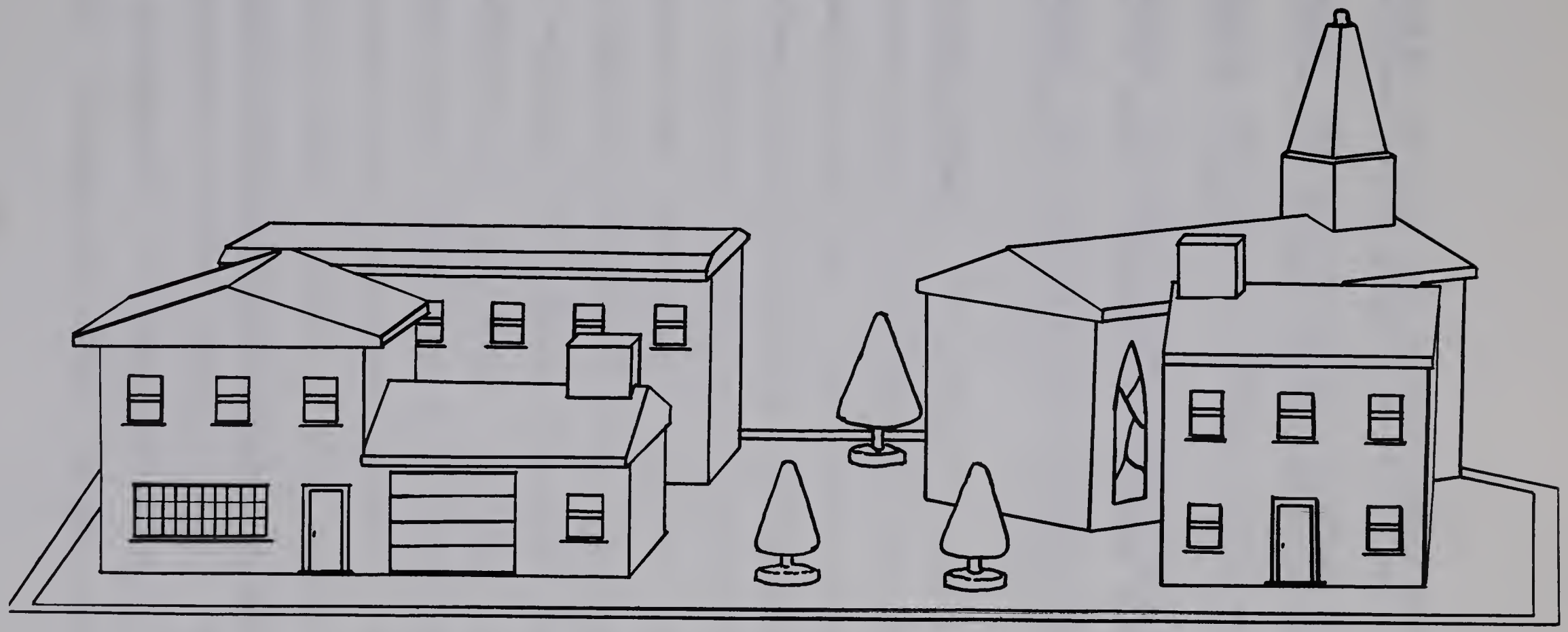


Figure 12. Card 5 used for Task IV.

Figure 8. The first card contained appropriate base area symbols but it was a mirror image of the correct map.

Figure 9. This card was a profile depicting the block from approximately the same viewpoint as that seen by the subject.

Figure 10. This card was an oblique profile depicting a view from the left of the block.

Figure 11. The fourth card was a correct map of the block using base area symbols to represent the buildings on the block.

Figure 12. This card was a profile depicting the block from the subject's viewpoint but more nearly representing the horizontal view.

Map Drawing (Task V). In an effort to determine whether guessing might have occurred in the previous task, each subject was asked to draw a map of the same block. It was felt that the subject's understanding of base area symbols could better be examined through drawing of the map. It was also theorized that this task would be completed successfully at a later stage than mere selection of the correct map.

Each subject was provided with a piece of paper the size of the block. On the table was a small box containing colored pencils, a ruler, cardboard strips, and a pencil. The subject was then asked to draw a map of block 3 using any or all of the materials provided. Although no time limit was set, it was suggested that the map be completed within ten minutes. However, no-one was refused extra time.

Tasks in Section B--Transition from Map Symbols to Models of Reality

The basis for the tasks in this section was a large map of the model town (see Figure 13). Only one block was exposed for tasks VI, VII, and VIII. The subject was required, through a series of tasks,

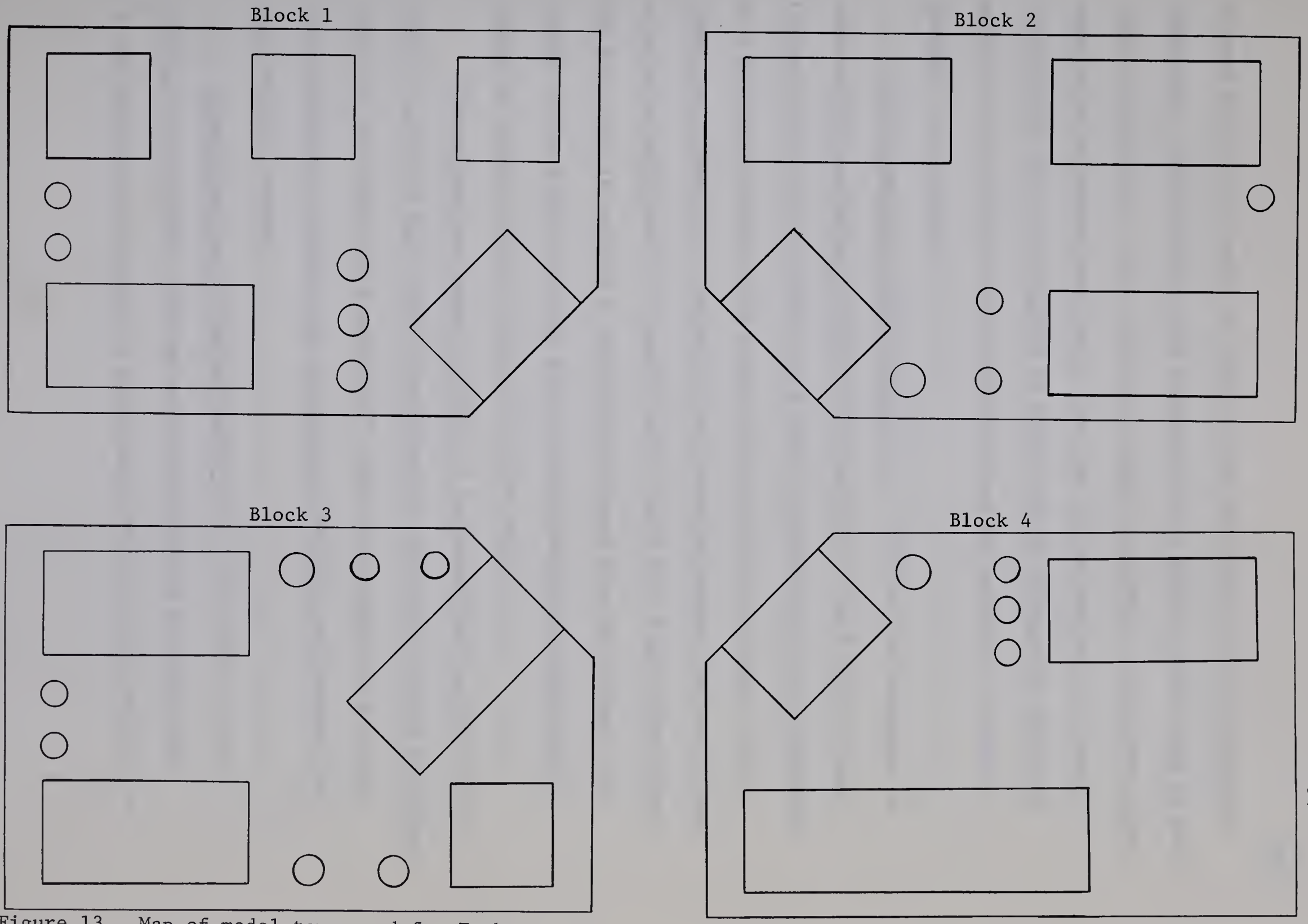
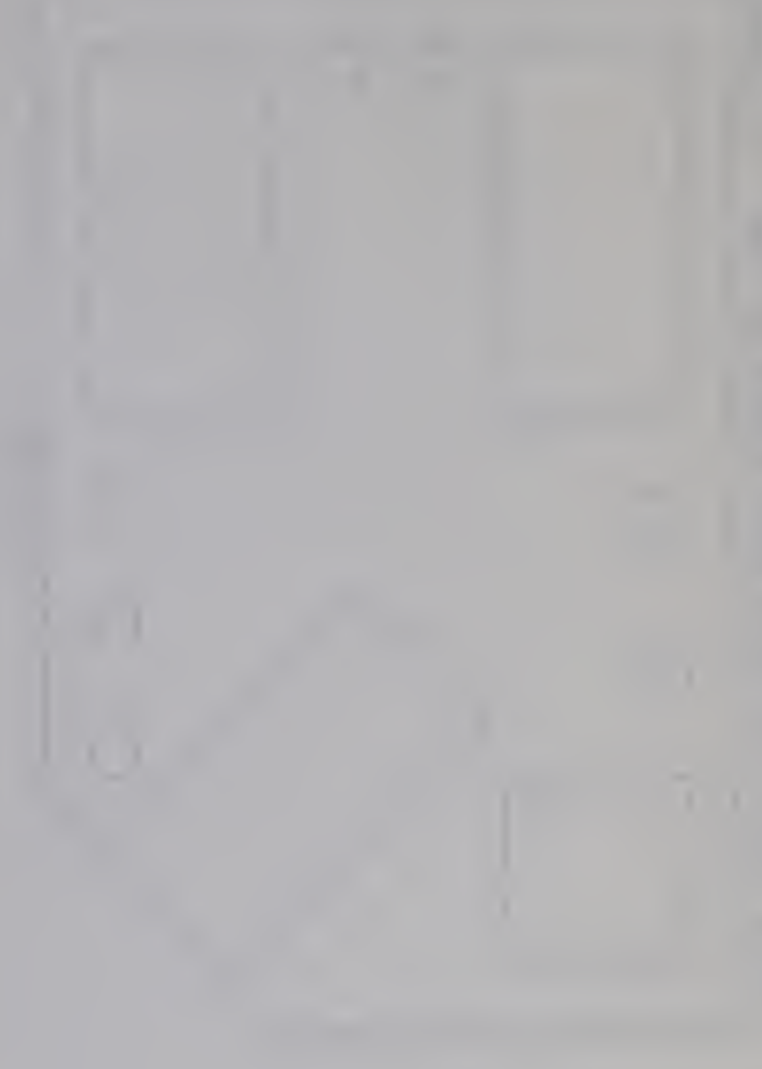
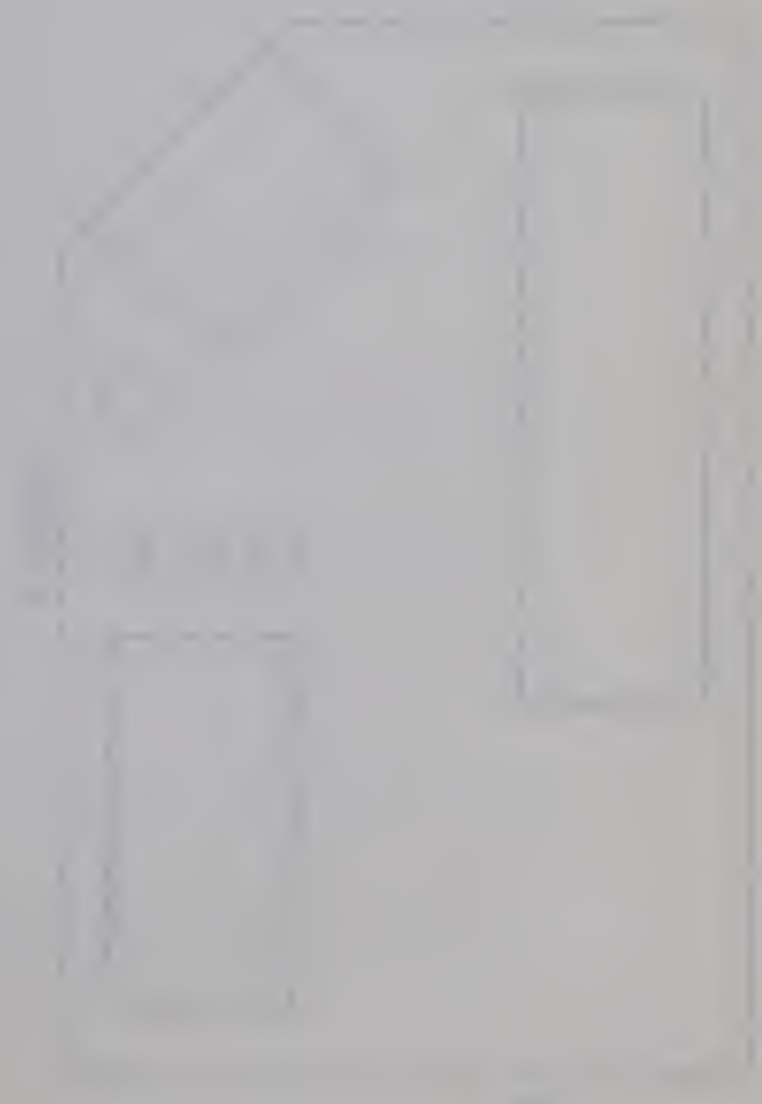


Figure 13. Map of model town used for Tasks VI-IX.





to work back to the model of reality that the symbols on the map might represent. The materials were essentially the same as those used in the tasks in section A. Each subject was again required to select and place symbols on an appropriate block. No time limits were set. It was hypothesized that the sequence of tasks from VI through IX inclusive would be more difficult for each child than the sequence of tasks I through V in section A.

Two-Dimensional Symbols (Task VI). This task was designed to examine the development of the child's ability to read and to visualize from the abstract symbols on a map by transferring the information to a different setting (the base) and in another form (paper two-dimensional symbols). The map of the four-block-model town was placed on a table and blocks 1, 3, and 4 were covered with heavy brown paper. The base used in section A, which was the same size as the map, was placed to the left of the map and the two-dimensional symbols were placed on another table to the left of the subject.

The subject was asked to build up the same block on his "little town" by using as many cards as necessary to show "how big the buildings would be" and "where they would be." After the symbols were placed, the investigator recorded the information precisely and removed the cards without comment.

Three-Dimensional Symbols (Task VII). The purpose of this task and the apparatus involved was similar to the previous task. It was designed to examine the development of the child's ability to

read and to visualize the abstract symbols on a map by transferring the information to the different setting of the base and in the form of three-dimensional symbols which to the subject were "pretend" or "imaginary buildings". The apparatus and instructions were the same as in the previous task except that the two-dimensional symbols were replaced by the three-dimensional styrofoam blocks. The examiner recorded the information and removed the blocks from the base without comment.

Scale Models (Task VIII). The setting for this task was the same as in the previous two tasks except that the subject now selected and placed realistic buildings on a base to indicate what the subject felt each symbol represented. As in the two previous tasks, the subject was asked to build up the same block (block 2) on his "little town" by using as many buildings as necessary to show how big they should be and where they were to be located. Again the examiner recorded the information and removed the buildings without comment.

Symbol Identification (Task IX). This task was designed to examine the state of development of a child's ability to identify on a photograph of the model town some of the buildings which are represented by the base area symbols on a map of the same model town. It was hypothesized that being able to identify buildings on a photograph, itself a symbol of reality, by "reading" a map and interpreting the symbols would constitute the simplest of the tasks in section B.

A large map of a four block town used in tasks VI, VII, and

VIII of this section was placed on a table.[9] A corresponding vertical photo was placed on the table to the left of the map.[10] The examiner placed numbers from 1-4 on four different symbols on the map and asked the child to identify, on the photo, the building which was represented by the symbol. The examiner noted the choice of each subject.

III. THE TESTING PROGRAM

The entire test battery was administered to the sample of one hundred twenty during the latter part of May and the beginning of June, 1965. The intelligence test was administered in group sessions at each school. The Base Area Symbols Test was administered to each subject individually in a secluded room so there would be a minimum of interruption. Only the subject being tested and the examiner were present. The examiner was careful to see that the testing situation and the instructions did not vary from subject to subject.

The examiner talked to all subjects at a group session about the testing program before it began. The subjects were given an indication of how they were selected and what types of experiences they would encounter. After a brief outline of the test battery the subjects were permitted to ask questions and withdraw if they felt they could not

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[9] See Figure 13, Supra.

[10] See Figure 3, Supra.

cooperate. All subjects accepted the testing program and were highly cooperative. All parents of subjects in the sample permitted their children to participate in the testing program.

The intelligence test was administered at one sitting and the Base Area Symbols Test was administered individually at a later date. Before beginning the individual test the examiner chatted with each subject about school, models, and air travel being sure to include the question, "Have you travelled in an airplane recently?" If the child said, "Yes" the examiner asked, "When?" and "Where did you go?" Then each subject was asked to examine the model town carefully before the testing actually began. The model town was the only visible apparatus when the subject entered the room. Other materials, however, were placed so that they could be displayed according to direction with a minimum of activity and disturbance.

IV. CODING AND SCORING PROCEDURES

Information regarding the chronological age, number of years at school, and occupation of each subject was obtained from the cumulative report cards kept in the school. Children who had been accelerated or who had repeated a grade could thus be excluded from the sample. Socio-economic status of the parents was coded 1, 2, or 3 representing high, middle, and low status according to the Blishen Occupational Class Scale. The chronological age of each subject was coded in years and fractions thereof to two decimal places.

Following is an outline of the method used to score each subject's performance on the tests. Scoring procedures for all tasks except the Lorge-Thorndike Intelligence Test, form B which was scored according to the manual, were developed by the examiner.

A copy of the score sheet which was used by the investigator is found in Appendix C.

Section A

Photograph Identification (Task I). Subjects who selected the correct photograph representing the vertical view of the model town were given a score of twelve. Those who selected any one of the five incorrect photographs were given zero. This scoring arrangement was decided upon because the examiner felt that each task of section A and B were of equal value and since it appeared that twelve was a common denominator, the zero or twelve basis was used.

Three-Dimensional Symbols (Task II). Three aspects were considered in scoring each subject's performance on this task. A subscore of four was given if the subject worked on the appropriate block of the base (block 3) because it was decided that this aspect was of equal importance with the selection and placement of the symbols and would therefore merit one third of the twelve points. A score of zero, one, two, three, or four was given for the number and correct size of the symbols used. A small margin of error in size (three quarters of an inch in length and/or width) of the symbol was tolerated. A third subscore of zero, one, two, three, or four was awarded for the proper

orientation of the symbols upon the block. Points were given if the symbols were placed in the proper quarter of the block. Points were not given if the symbol extended over the edge of the block and if the one symbol was not placed on a diagonal as necessary. Thus it was possible for a subject to score from zero to twelve points in this task.

Two-Dimensional Symbols (Task III). The basis for scoring this task was identical to that for the previous task involving three-dimensional symbols. The same margin of error in size and placement was permitted. Thus, a subject could obtain a score of zero to twelve on this task.

Map Selection (Task IV). Subjects who selected the correct map of the one block of the model town were given a score of twelve. Those who selected any of the other four cards as being the correct map scored a zero. The rationale behind this scoring was the same as for task I.

Map Drawing (Task V). Three aspects were considered in scoring the map that each subject drew. A score of one, two, three or four was given if the child used base area symbols. One point was given for each base area symbol used but a score of zero was awarded if the child drew anything other than a base area symbol for each of the four buildings on the model. If base area symbols were used, then a score of zero, one, two, three, or four was awarded for the correct size of the symbol. Three of the symbols were three inches by six inches and for these a point was given for each if the length of

the child's symbol exceeded the width. The fourth symbol was a three inch square and a point was awarded if one dimension was no less than half and no more than one and one half times the other dimension. A third subscore of zero to four was awarded for the orientation of the symbols on the map. One point was awarded for the diagonally placed symbol and one additional point was awarded for each of the other three symbols if they were placed within the proper quarter of the block of the map. No points were awarded for placement of symbols along a common base line. Thus, a child could score from zero to twelve points in this task.

The five tasks of section A each had a possible value of twelve points so it was possible for each subject to score from zero to sixty points in this section.

Section B

Two-Dimensional Symbols (Task VI). The scoring for this task was identical with that of task III in section A. The same aspects were considered and the same ranges of scores were awarded. The margin of error permitted was also the same. Thus, a subject could obtain a score of zero to twelve on this task.

Three-Dimensional Symbols (Task VII). The method of scoring this task was identical with that used in task II in section A. A score of zero to twelve was possible for this task.

Scale Models (Task VIII). The basis for scoring this task was identical to that used for task II in section A and task VII in section B. Because the variation in the size of the realistic buildings to be selected as answers was small, no points were awarded unless the size chosen was exact. The number of floors contained in the building selected was not considered. A score of zero to twelve was possible for this task.

Symbol Identification (Task IX). Three points were awarded for each of the four buildings correctly identified on the photograph to represent the four symbols on the large map. Thus, a subject could score zero, three, six, nine, or twelve on this task.

The four tasks of section B each had a possible value of twelve points so it was possible for a child to score from zero to forty-eight points in this section.

V. THE STATISTICAL PROCEDURES

The Base Area Symbols Test was designed by the investigator. Five separate tasks made up the first section and four tasks comprised the second section. According to the scoring procedures used, it was possible for each of the one hundred twenty subjects in the sample to obtain a dichotomous score of zero to twelve on tasks I and IV, a score of zero, three, six, nine or twelve on task IX and a continuous score of zero to twelve on the remaining tasks. Chronological age, intelligence quotient and grade level of each subject were tabulated as

continuous data. The variables of sex, socio-economic status and air travel experience were coded as being dichotomous.

According to Ferguson, the Pearson product-moment measure of correlation is used, "...where the variables are quantitative, that is, of the interval or ratio type."[11] Ferguson further stated that the, "biserial correlation is a measure of the relationship between a continuous and a dichotomous variable, it being assumed that the variable underlying the dichotomy is continuous and normal."[12]

While it was recognized that the assumption that the variables were quantitative was violated somewhat, Pearson product-moment correlations were found to determine the relationships between the nine tasks, between the tasks and each section total score, and between the tasks and the combined totals for both sections of the Base Area Symbols Test. Biserial correlations were also found to determine the relationship between the two tasks that were dichotomously scored and the other task and section scores. These latter calculations were found to be identical with the Pearson product-moment correlations. The relationship between each subject's score on the Base Area Symbols Test and the variables of grade level, chronological age, and intelligence was assessed by finding the

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[11]George A. Ferguson, Statistical Analysis in Psychology and Education (New York: McGraw-Hill Book Company, Inc., 1959), p. 87.

[12]Ibid, p. 203.

Pearson product-moment correlations between these variables and the test scores. Biserial correlation coefficients were calculated to determine the relationship between the variables of sex, socio-economic status, and recent air travel experience and the test scores. As noted above, the biserial correlation coefficients were found to be identical to the Pearson product-moment correlations in determining the relationship between the variables and the test scores.

The scoring procedure discussed earlier in this chapter was such that some of the scores may have tended to inflate the correlations somewhat. In order to attempt to compensate somewhat the investigator accepted only those correlations that were significant at the .01 level. According to Ferguson, for the sample of one hundred twenty used in this study $r \geqq .254$ in order to be significant at the .01 level.[13]

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13 Ibid., p. 315.

CHAPTER IV

THE RESULTS OF THE INVESTIGATION

This chapter is devoted to an outline of the results for the total sample, a discussion of the statistical analyses which were carried out, and a report of the examiner's observations of child reaction to the tasks. A summary of the findings concludes the chapter.

I. RESULTS FOR THE TOTAL SAMPLE

Nature of the Sample

The sample of 120 children used in this study as indicated in Chapter III was composed of ten males and ten females at each grade from one to six inclusive selected from two schools in the Edmonton, Alberta, Public School System. The subjects ranged in age from six years seven months to twelve years seven months and had intelligence quotients ranging from seventy-seven to one hundred forty-three when measured by the non-verbal form B of the Lorge-Thorndike Intelligence Test. Table 1 shows the means and standard deviations for chronological age and intelligence for each grade level from one through six.

To determine socio-economic status the subjects were divided into three groups as measured by the Blishen Occupational Class Scale. The high socio-economic group was composed of twenty-seven subjects, the middle group had fifty-seven members, and the low socio-economic group had thirty-six members.

TABLE I

MEANS AND STANDARD DEVIATIONS FOR CHRONOLOGICAL AGE AND INTELLIGENCE FOR THE SAMPLE

Grade	N	Chronological Age		Intelligence	
		Means	S.D.	Means	S.D.
One	20	7.01	0.25	108.35	14.90
Two	20	7.85	0.31	97.50	10.67
Three	20	8.83	0.26	98.95	11.48
Four	20	9.79	0.34	106.80	11.63
Five	20	10.58	0.46	122.45	11.24
Six	20	11.53	0.54	117.05	11.06

The Test

A copy of the Base Area Symbols Test used in this investigation may be found in Appendix B. It consisted of two series of task-type tests. The first series of five tasks was designed to measure the subject's ability to represent objects in the form of a map. The second series was designed to measure the subject's ability to represent, through the use of models, the reality that is represented by base area symbols.

Results of Task I--Photograph Selection

The first task was designed to determine when a child was able to visualize what objects look like from above, a view which the child could not actually see. The task consisted of selecting the one of six photographs of the model town which was taken from the vertical position. It was felt that being able to visualize this accurately is a vital step in being able to see the relationship between base area symbols and the reality they represent.

The results of this task are presented in Table II. The table indicates that the percentage of children selecting the correct photograph increased through the grades from one through six with the more substantial increases occurring after grades two and five. It was not until the third grade that more than half of the subjects were able to identify the correct photograph. Only ninety percent of the grade six children made the correct selection. The major distractors were photographs five[1] and six[2] which

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[1]See figure 6, Supra.

[2]See figure 7, Supra.

TABLE II

PERCENTAGE OF SUBJECTS AT EACH GRADE SELECTING THE PHOTOGRAPHS ONE TO SIX ON TASK IV

Grade	Photograph Selected					
	1	2[a]	3	4	5[b]	6[c]
One	10	40	5	5	20	20
Two	0	45	10	5	20	20
Three	15	70	0	0	10	5
Four	0	70	10	5	5	10
Five	0	70	0	0	25	5
Six	0	90	0	5	5	0
Totals (N = 120)	4.17	64.17	4.17	3.33	14.17	10.00

NOTE: [a]The correct photograph (figure 3).

[b]The oblique view of the model (figure 6).

[c]A horizontal view of the model (figure 7).

were oblique and nearly horizontal views of the model. The latter two photographs were those taken from most nearly the same angle as the child actually saw the model. The fifth photograph was selected by over fourteen percent of the total sample and the sixth photograph was selected by ten percent. In all but one instance, the highest percentage of children choosing the latter two photographs were at the first and second grade levels with a gradual decline through grades three to six.

Results of Task IV--Map Selection

Task IV was designed to examine the subjects' understanding of a map consisting of the base area symbols only, as compared with profiles of the same block of the model town. The subjects were shown five cards and asked to identify the one which was a correct map of one block of the model town. Table III presents the percentage of children at each grade who chose each of the five cards as being the correct map.

An examination of Table III reveals that one-third of the total sample identified the correct map of the block of the model from those represented by the five cards. It was not until the fifth grade that at least fifty percent of the subjects were able to identify the correct map and even at the sixth grade level only seventy percent could do so. The largest increase in ability to do this task came at the end of the fourth grade. However, it should be noted that fifteen percent of the subjects at each of the grade one and two levels were able to identify the map from among the cards presented.

As was the case in the photograph identification task outlined above,

TABLE III

PERCENTAGE OF SUBJECTS AT EACH GRADE SELECTING EACH OF THE FIVE CARDS IN TASK IV

Grade	Cards Selected				
	1	2	3	4*	5
One	10	25	10	15	40
Two	5	25	20	15	35
Three	0	50	0	25	25
Four	15	30	0	25	30
Five	5	30	0	50	15
Six	0	10	5	70	15
Total (N = 120)	5.83	28.33	5.83	33.33	26.66

*The correct map (figure 11).

the major distractors among the cards in this task were the profiles, both horizontal and oblique, which were views most nearly those which the subjects actually saw when they looked at the model. Over twenty-six percent of the subjects chose the horizontal profile[3] as being the correct map of the block. Although there was a definite decline in this choice through the grades, results indicate that fifteen percent of the subjects at each of grades five and six selected this card. On the other hand, forty percent of the subjects at the first grade level selected this profile as being the correct map. The other major distractor was the oblique profile[4] which was selected by more than twenty-eight percent of the sample. No major decline was noted in the percentage of subjects selecting this distractor through the grades although only ten percent of the subjects at the grade six level chose this card as being the correct map. Fifty percent of the grade three subjects chose this card which was selected by only twenty-five percent of the sample at each of grades two and three.

Results of Task V--Map Drawing

To aid in determining the subjects' development of the concept of base area and to attempt to determine whether guessing may have occurred in task IV, each subject was asked to draw a map of the same block used in task IV. The percentages of subjects obtaining scores of zero to four on each of the three aspects considered--base area symbols, size of symbols,

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[3]See figure 12, Supra.

[4]See figure 9, Supra.

and orientation of symbols--are presented in Table IV. Table IV presents the percentage of subjects obtaining total scores of zero to four, five to eight, and nine to twelve on task V.

An examination of Table IV indicates a steady decline through grades one to six in the percentage of subjects scoring zero on the aspect dealing with base area symbols. On the other hand, there was a gradual increase through the grades in the percentage of subjects obtaining a score of four obtained by using base area symbols. The largest increase in the percentage of subjects obtaining a maximum score on this aspect occurred between grades five and six but even at the grade six level only seventy-five percent of the sample obtained a score of four by using four base area symbols. It should be noted that more than fifty-four percent of the total sample obtained a score of zero and more than thirty percent of the total sample obtained the maximum score of four. The remaining fifteen percent of the total sample obtained a score of one, two, or three. This indicated that the subjects in this sample could largely be placed in two categories: those who had a knowledge of base area symbols and those who had not any grasp of this concept.

In examining the percentages of subjects obtaining scores from zero to four for the correct size of the symbol used, one finds a very close parallel with the aspect discussed above. The percentage of subjects at each grade level who scored zero for the size of symbols used was identical with those for the use of base area symbols. There was a gradual increase through the grades from one through six in the percentage of subjects

TABLE IV

PERCENTAGE OF SUBJECTS OBTAINING SCORES ZERO TO FOUR ON TASK V--MAP DRAWING

Grade	Base Area					Size					Orientation				
	0	1	2	3	4	0	1	2	3	4	0	1	2	3	4
One	85	0	0	5	10	85	0	5	5	5	30	15	10	35	30
Two	75	10	5	0	10	75	15	0	0	10	15	5	20	45	15
Three	70	15	0	5	10	70	15	0	5	10	5	5	20	25	45
Four	35	20	5	5	35	35	20	15	10	20	0	5	10	45	40
Five	35	15	0	5	45	35	15	0	30	20	0	0	5	20	75
Six	25	0	0	0	75	25	0	0	10	65	5	0	5	10	80
Total	54.16	10.00	1.67	3.33	30.83	54.16	10.58	3.33	10.00	21.16	9.16	5.00	11.67	26.66	47.50

obtaining the maximum score of four for the size of symbol used. The largest increase occurred between grades five and six with only a slight increase noted from grades one through five. It may be noted that the percentage of subjects at the grade six level scoring four was equal to the combined totals of the subjects from grades one to five. Only twenty-one percent of the total sample obtained the maximum score of four with nearly twenty-four percent scoring one, two, or three.

Forty-seven percent of the subjects scored the maximum four points for placing the symbols on the map correctly. While the increase through the grades was not steady and consistent, seventy-five and eighty percent of grades five and six respectively obtained the maximum score with the remaining subjects generally obtaining near maximum scores. Nearly seventy-five percent of the total sample obtained a score of three or more of the maximum four indicating that the aspect of placement of the symbols was easier for the subjects than the use and drawing of the base area symbols.

An examination of Table V indicates a somewhat bimodal distribution of total scores on task V. High percentages of subjects at the lower grades scored in the zero to four category while subjects at the fifth and sixth grade tended to be in the nine to twelve range. Subjects at the fourth grade level were evenly divided among the three categories. Of the sample, over fifty-five percent scored from zero to four with over thirty-one percent scoring from nine to twelve of a possible twelve points. This

TABLE V

PERCENTAGE OF SUBJECTS OBTAINING TOTAL SCORES 0 - 4, 5 - 8, AND 9 - 12 ON TASK V--MAP DRAWING

Grade	Total Scores		
	0 - 4	5 - 8	9 - 12
One	95	0	5
Two	75	15	10
Three	70	15	15
Four	35	30	35
Five	35	15	50
Six	25	0	75
Total (N = 120)	55.83	12.50	31.66

indicates that subjects generally were able to do the task well or they were completely unable to do it, leaving only about twelve percent of the sample who obtained in-between scores of from four to eight. These results indicated a gradual increase in the total scores through the grades but the largest and most noticeable increase came at the grade six level.

Results of Task II--Three Dimensional Symbols

This task was designed to examine the degree to which the subject was able to represent the realistic buildings of the model by use of three-dimensional symbols. The subject was required to choose the appropriate symbols for block three and then place them on the base provided. The percentages of subjects obtaining scores of zero to four on each of the three aspects considered--block used, size of symbols, and orientation of symbols--are presented in Table VI. Table VII presents the percentage of subjects obtaining total scores of zero to four, five to eight, and nine to twelve on task II.

An examination of Table VI reveals that seventy percent of the subjects placed the symbols on the correct block while over twenty-six percent used block four which was nearest to the model and the block being replicated. Although not consistent, there was an increase through the grades in the percentage of subjects using the correct block and a gradual decline in the use of the block closest to the model. Slightly less than two percent of the total sample placed the symbols on each of blocks one and two, those which were farthest away from the subject.

TABLE VI

PERCENTAGE OF SUBJECTS USING BLOCKS ONE TO FOUR AND OBTAINING SCORES OF ZERO TO FOUR ON TASK II THREE-DIMENSIONAL SYMBOLS

Grade	Block*				Size					Orientation				
	1	2	3	4	0	1	2	3	4	0	1	2	3	4
One	5	0	50	45	15	0	5	40	40	10	0	0	20	70
Two	0	0	40	60	0	5	15	30	50	0	5	0	40	55
Three	5	5	75	15	5	5	15	20	55	5	0	5	10	80
Four	0	5	90	5	0	0	15	40	45	0	0	0	10	90
Five	0	0	80	20	0	0	5	30	65	0	0	0	5	95
Six	0	0	85	15	0	5	5	20	70	0	5	0	0	95
Total (N=120)	1.66	1.66	70.00	26.66	3.30	2.50	10.00	30.00	54.16	2.50	1.66	0.83	15.0	80.83

*Numbers one to four indicate the block on which subjects placed the symbols. Percentages indicate the use of each block.

TABLE VII

PERCENTAGE OF SUBJECTS OBTAINING SCORES OF ZERO TO FOUR, FIVE TO EIGHT, AND NINE TO TWELVE ON TASK II--THREE-DIMENSIONAL SYMBOLS

Grade	Total Scores		
	0 - 4	5 - 8	9 - 12
One	10	45	45
Two	5	55	40
Three	10	15	75
Four	0	10	90
Five	0	20	80
Six	5	10	85
Total (N = 120)	5.00	25.83	69.16

Further examination of Table VI shows that nearly eighty-five percent of the total sample obtained a score of three or four of a maximum four for selecting the correct size of symbol. Although not consistent, there was a gradual increase through the grades in the percentage of subjects that selected four symbols of the correct size. At the same time there was a fairly sharp decline in the percentage of subjects at each grade level who obtained a score of zero or one for choosing symbols of the correct size.

Table VI also presents the percentage of subjects who obtained scores from zero to four for the proper placement of the symbols upon the block of the base. With the exception of subjects at the grade two level, there was a steady increase in the percentage of subjects at each grade level who placed each of the four symbols correctly. However, even at the grade two level, ninety-five percent of the subjects placed three or four of the four symbols correctly. Of the total sample, over ninety-five percent of the subjects placed at least three of the four symbols correctly, indicating that the aspect was not difficult for subjects at this level.

An examination of Table VII reveals that nearly seventy percent of the total sample scored between nine and twelve of the maximum twelve points on task II. Only five percent of the entire sample scored four or less. A large increase in the percentage of subjects who obtained nine to twelve points occurred between grades two and three and a corresponding large drop occurred at the same level in the percentage of subjects scoring five to eight points. Ninety percent of the subjects at the grade four level obtained nine to twelve points making subjects at this level the best performers on this task.

Results of Task III--Two Dimensional Symbols

This task was designed to determine the degree to which the subjects could represent models of reality by the use of two dimensional symbols. The subject was required to select symbols of the appropriate size for block three and then place them on the base provided. Table VIII presents the percentages of subjects obtaining scores of zero to four on each of the three aspects considered--block used, size of symbols, and orientation of the symbols. The percentages of subjects obtaining total scores of zero to four, five to eight, and nine to twelve on task III are presented in Table IX.

An examination of Table VIII reveals that over seventy-one percent of the total sample placed the symbols on the correct block while slightly less than twenty-six percent used block four. Each of the figures is within two percent of the corresponding performance in task II outlined above. The increase in the percentage of subjects through the grades who used the correct block is almost identical to the results of the previous task. The increase over results in task III in the percentage of the total sample using the correct block resulted in slight declines in the percentage of subjects using each of blocks one, two, and four.

Further examination of Table VIII reveals that, although over fifty percent of the total sample scored three or four of the maximum four points for choosing the correct size of two dimensional symbol, the subjects at all grades had considerable difficulty with this task. Only two and one half percent scored a zero and after the third grade all subjects scored

TABLE VIII

PERCENTAGE OF SUBJECTS USING BLOCKS ONE TO FOUR AND OBTAINING SCORES OF ZERO TO FOUR ON TASK III TWO-DIMENSIONAL SYMBOLS

Grade	Block*				Size					Orientation				
	1	2	3	4	0	1	2	3	4	1	2	3	4	5
One	0	0	50	50	5	10	35	30	20	5	0	0	25	70
Two	0	0	45	55	5	40	20	30	5	0	0	10	35	55
Three	5	0	75	20	5	15	45	20	15	5	0	0	10	85
Four	0	5	90	5	0	15	20	40	25	0	0	5	5	90
Five	0	0	80	20	0	10	20	45	25	0	0	0	0	100
Six	0	0	90	10	0	10	20	30	40	0	5	0	0	95
Total	0.83	0.83	71.66	25.83	2.50	16.66	26.66	32.50	21.66	1.66	0.83	2.50	12.50	82.50

*Numbers one to four indicate the block on which subjects placed the symbols. Percentages indicate the use of each block.

TABLE IX

PERCENTAGE OF SUBJECTS OBTAINING SCORES OF ZERO TO FOUR, FIVE TO EIGHT, AND NINE TO TWELVE ON TASK III--TWO-DIMENSIONAL SYMBOLS

Grade	Total Scores		
	0 - 4	5 - 8	9 - 12
One	10	45	45
Two	35	25	40
Three	5	20	75
Four	5	10	85
Five	0	20	80
Six	5	5	90
Total (N = 120)	10.00	20.83	69.16

at least one point. Subjects at the sixth grade level scored most points with subjects at grades five, four, one, three, and two, in that order, scoring fewer of the total possible number of points. In comparison with the same aspect on task II, subjects at all grades found it more difficult to select the correct size of two-dimensional symbols than the three-dimensional.

The problems of correctly placing the symbols on the block in this task resulted in scores almost identical to those of the previous task. Subjects at the fifth grade level obtained perfect scores while those at the grade two level had the greatest difficulty with this aspect of task III. However, ninety-five percent of the total sample obtained a score of three or four of the maximum four so this was not found to be a difficult aspect of this task.

Examination of Table IX reveals that nearly seventy percent of the total sample obtained between nine and twelve points of a maximum twelve on task III. Ten percent of the total sample scored zero to four and the remaining twenty percent had scores of from five to eight. Subjects at the sixth grade had the best scores with subjects at the second grade level having the lowest scores. With the exception of grade two, there was a gradual increase in competence through the grades from one to six in the performance of this task as exhibited by the scores obtained. Comparison of Tables IX and VII indicates a very close parallel in the performance of the subjects at each grade level on task III and II. Only those subjects at the second

and fourth grade levels did more poorly on the task involving two dimensional rather than three dimensional symbols. Performance at other grades remained constant or improved slightly.

Results of Task VI--Two Dimensional Symbols

This first task of the second section was designed to determine the development of the child's ability to read and visualize from the abstract symbols on a map by transferring the information to the base by use of two dimensional symbols. The subject was required to select symbols of the appropriate size for block two and then place them on the base provided. Table X presents the percentage of subjects obtaining scores of zero to four on each of the three aspects considered--block used, size of symbols, and orientation of the symbols. The percentage of subjects obtaining total scores of zero to four, five to eight, and nine to twelve on task VI are presented in Table XI.

Examination of Table X reveals that over seventy-three percent of the total sample placed their choice of symbols on the correct block (block 2) while just over seventeen percent used block four, probably because it was most convenient. Blocks one and three were used by small percentages of the total sample. There was a substantial increase after grade two in the percentage of subjects at each of grades three to six who used the correct block with subjects at the fourth grade obtaining the best results. No definite developmental pattern was evident throughout, however nearly sixty percent of the total sample had a perfect score of four obtained by selecting four symbols of the correct size. Another

TABLE X

PERCENTAGE OF SUBJECTS USING BLOCKS ONE TO FOUR AND OBTAINING SCORES OF ZERO TO FOUR ON TASK VI--TWO-DIMENSIONAL SYMBOLS (SECTION B)

Grade	Blocks*				Size					Orientation				
	1	2	3	4	0	1	2	3	4	0	1	2	3	4
One	0	45	15	40	5	10	0	35	50	5	0	5	30	60
Two	10	55	15	20	0	5	15	40	40	0	0	0	35	65
Three	10	80	0	10	0	5	10	40	45	0	5	0	10	85
Four	0	95	0	5	0	0	10	20	70	0	0	0	10	90
Five	0	80	0	20	0	0	5	30	65	0	0	5	10	85
Six	0	85	5	10	0	0	5	10	85	0	0	0	5	95
Total (N=120)	3.30	73.33	5.83	17.50	0.83	3.30	7.50	29.16	59.16	0.83	0.83	1.66	16.66	80.00

*Numbers one to four indicate the block on which subjects placed the symbols. Percentages indicate the use of each block.

TABLE XI

PERCENTAGE OF SUBJECTS OBTAINING SCORES OF ZERO TO FOUR, FIVE TO EIGHT, AND NINE TO TWELVE ON TASK VI--TWO-DIMENSIONAL SYMBOLS

Grade	Total Scores		
	0 - 4	5 - 8	9 - 12
One	15	40	45
Two	5	40	55
Three	5	15	80
Four	0	5	95
Five	0	20	80
Six	0	15	85
Total (N = 120)	4.17	22.50	73.33

twenty-nine percent obtained a score of three, seven and one-half percent had scores of two, and the remainder had scores of zero or one. Although not consistent, there was a gradual increase in the percentages of subjects at grades one through six who obtained scores of four. The performance of the fourth grade subjects was almost equal to that of the sixth grade which was best, with subjects at grade five, three, one, and two performing in that order.

Further examination of Table X indicates that eighty percent of the total sample placed four of the four symbols correctly on the base. An additional sixteen percent of the total sample scored three of the maximum four so performance on this aspect was generally very good. Once again, although not consistent, there was a gradual increase through the grades in the percentage of subjects scoring the maximum for proper orientation of the symbols.

Table XI shows that over seventy-three percent of the entire sample obtained total scores of between nine and twelve and a further twenty-two and one-half percent obtained scores of five to eight on task VI. Four percent of the sample scored between zero and four. The largest encrease in performance occurred between grades three and four with the subjects at the fourth grade level having the highest performance. With this exception there was a gradual increase through the grades from one to six in the percentage of subjects obtaining scores of nine to twelve. No subjects at grades four to six scored in the zero to four bracket. Forty percent of the subjects at each of grades one and two obtained scores of

five to eight. Only minor variations in performance occurred among the subjects at grades three to six.

Results of Task VII--Three Dimensional Symbols

Task VII was designed to determine the development of the child's ability to read and visualize the abstract symbols on a map by transferring the information to a different setting through use of three dimensional symbols which were to be selected from a group supplied. After the selection of the symbol the subject was required to locate it on block two of the base provided. Table XII presents the percentages of subjects obtaining scores of zero to four on each of the three aspects considered--block used, size of symbols, and orientation of the symbols. Table XIII presents the percentages of subjects obtaining total scores of zero to four, five to eight, and nine to twelve on task VII.

A comparison of the Table XII with Table X showing results of the previous task indicates that only very minor differences occurred in the performance of the subjectswith respect to the block on which they placed the symbols. Just over seventy-four percent of the total sample used the correct block (block 2) and over seven percent and sixteen percent used blocks three and four respectively. The remainder of the subjects used block one. All subjects at the fourth grade level used the correct block and apart from this exception there was a gradual increase through grades one to six in the percentage of subjects who used block two. Subjects at the first grade level who did not use the correct block preferred either block three or four which may have been used because of the proximity to the subject.

TABLE XII

PERCENTAGE OF SUBJECTS USING BLOCKS ONE TO FOUR AND OBTAINING SCORES OF ZERO TO FOUR ON TASK VII-- THREE-DIMENSIONAL SYMBOLS (SECTION B)

Grade	Blocks*				Size					Orientation				
	1	2	3	4	0	1	2	3	4	0	1	2	3	4
One	0	45	15	40	5	5	15	45	30	5	0	5	25	65
Two	10	55	15	20	0	0	5	50	45	0	0	0	25	75
Three	5	80	5	10	5	0	10	35	50	5	0	0	15	80
Four	0	100	0	0	0	0	5	50	45	0	0	0	5	95
Five	0	80	0	20	0	0	10	25	65	0	0	10	10	80
Six	0	85	5	10	0	0	0	30	70	0	0	0	0	100
Total (N=120)	2.50	74.16	7.50	16.66	1.66	0.83	7.50	39.16	50.83	1.60	0	2.50	13.33	82.50

*Numbers one to four indicate the block on which subjects placed the symbols. Percentages indicate the use of each block.

TABLE XIII

PERCENTAGE OF SUBJECTS OBTAINING SCORES OF ZERO TO FOUR, FIVE TO EIGHT, AND NINE TO TWELVE ON TASK VII--THREE-DIMENSIONAL SYMBOLS

Grade	Total Scores		
	0 - 4	5 - 8	9 - 12
One	10	45	45
Two	0	45	55
Three	5	15	80
Four	0	0	100
Five	5	15	80
Six	0	15	85
Total (N = 120)	3.30	22.50	74.16

Just over fifty percent of the total sample obtained the maximum score of four for selecting four symbols of appropriate size. Another thirty-nine percent obtained three of the maximum four points. Seven and one-half percent of the sample scored two with the remaining two and one-half percent scoring zero or one. Once again, a gradual increase in the quality of performance was indicated through the grades from one to six.

All of the subjects at the sixth grade level obtained perfect scores of four for placing the four symbols appropriately on the block. This was followed closely by ninety-five percent of the fourth grade subjects who also obtained scores of four. With the exception of the latter, there was a gradual increase through the grades in the quality of performance in placing the symbols correctly. Of the total sample, eighty-two and one-half percent obtained the maximum four points for proper orientation of the symbols. An additional thirteen percent scored three points leaving only about four percent scoring zero, one, or two. Only two subjects or one decimal six percent of the total sample were unable to place any of the symbols correctly.

Comparison of Tables XI and XIII indicates that only a very slight increase in the percentage of subjects obtaining scores of nine to twelve has occurred on the latter task. A slight decrease was noted in the percentage of subjects scoring four or less. With the exception of the fourth grade subjects who all scored between nine and twelve points on task VII, the other percentages are the same as those at each grade level in the previous task. Similarity of the tasks probably accounted for the close parallel in the results.

Results of Task VIII--Scale Models

Task VIII was similiar in design to the previous two except that realistic objects (buildings) were to be selected from a group to represent the symbols on block two of the map. As in previous tasks, each subject had to select the appropriate size and number of symbols and place them on block two of the base provided. Table XIV presents the percentages of subjects obtaining scores of zero to four on each of the three aspects considered--block used, size of symbols, and orientation of the symbols. Table XV presents the percentages of subjects obtaining total scores of zero to four, five to eight, and nine to twelve on task VIII.

An examination of Table XIV reveals that the percentage of subjects using the correct blocks for placement of the realistic objects for this task was almost identical to the two previous tasks. Over seventy-four percent of the total sample used block two for placement of the buildings in this task. Blocks three and four were used by nearly six percent and seventeen percent of the total sample. Only slightly over three percent used block one. The largest increase in quality of performance came after grade two. The total sample at the fourth grade level used the correct blocks. Apart from the performance of the fourth grade subjects, there was a steady increase through the grades in the percentage of subjects using block two.

Further examination of Table XIV indicates that sixty percent of the total sample obtained the maximum score of four for selecting the correct size of realistic objects in task VIII. An additional thirty-two

TABLE XIV

PERCENTAGE OF SUBJECTS USING BLOCKS ONE TO FOUR AND OBTAINING SCORES OF ZERO TO FOUR ON TASK VII

SCALE MODELS

Grade	Block*				Size					Orientation				
	1	2	3	4	0	1	2	3	4	0	1	2	3	4
One	0	45	15	40	5	5	10	20	60	5	0	5	25	65
Two	10	55	15	20	0	0	5	35	60	0	0	0	15	85
Three	10	80	0	10	0	0	15	50	35	0	5	0	15	80
Four	0	100	0	0	0	5	0	45	50	0	0	0	5	95
Five	0	80	0	20	0	0	0	35	65	0	0	5	10	85
Six	0	85	5	10	0	0	0	10	90	0	0	0	0	100
Total (N=120)	3.30	74.16	5.83	16.66	0.83	1.66	5.00	37.50	60.00	0.83	0.83	1.66	11.66	85.00

*Numbers one to four indicate the block on which subjects placed the symbols. Percentages indicate the use of each block.

TABLE XV

PERCENTAGE OF SUBJECTS OBTAINING SCORES OF ZERO TO FOUR, FIVE TO EIGHT, AND NINE TO TWELVE ON TASK VIII--SCALE MODELS

Grade	Total Scores		
	0 - 4	5 - 8	9 - 12
One	10	45	45
Two	0	45	55
Three	5	15	80
Four	0	5	95
Five	0	20	80
Six	0	15	85
Total (N = 120)	2.50	24.16	73.33

and one-half of the total sample scored three of the maximum four points. The remaining subjects scored zero, one, or two with less than one percent scoring zero. The subjects at grade six had the best performance with those at grades five, two, four, one, and three following in that order.

The last aspect presented in Table XIV indicated that eighty-five percent of the total sample obtained the maximum score of four for placing the four realistic objects correctly on the base provided. An additional eleven percent scored three while the remaining three percent scored zero, one, or two. The entire sample at the sixth grade level scored the maximum four points for orientation of the objects with subjects at grade four, two, five, three, and one following in order of performance. Only minor variations existed in the performance as over ninety-six percent of the total sample scored three or four of the maximum four points. Comparison of results with the same aspect in tasks VI and VII indicated a slight improvement in performance in this task.

Examination of Table XV reveals that the total performance of the subjects on task VIII was very similar to that of the previous two tasks. Over seventy-three percent of the sample scored between nine and twelve of the maximum twelve points on task VIII. In addition, over twenty-four percent scored between five and eight points, while the remaining two and one-half percent scored between zero and four points. Subjects at the fourth grade level had the best performance with subjects at grades six, five, three, two, and one performing in that order. As in previous tasks, the largest increase in quality of performance occurred after the second grade. Performance from grades three to six was very similar.

Results of Task IV--Symbol Identification

The final task of section B was designed to examine the development of the child's ability to locate on an actual photograph the buildings which were represented by the symbols on a map of the same area. The examiner placed a number on each of four symbols on the map and asked the subject to identify the building on a vertical photograph which each symbol represented. Table XVI presents the percentage of subjects obtaining scores of zero, three, six, nine and twelve determined by awarding three points for each of the four symbols correctly identified.

From an examination of Table XVI it is noted that sixty-two and one-half percent of the total sample correctly identified the four buildings on the photograph represented by the map symbols. An additional twenty-three percent scored nine points for three correct identifications. Except for subjects at the fifth grade level who had the best performance, there was a gradual increase through the grades from one to six in the quality of performance on this task. Only at the first grade level were there any subjects who could not identify any of the symbols by pointing out the corresponding reality on the photograph.

II. THE STATISTICAL ANALYSES OF THE RESULTS

An Analysis of the Sections and Tasks of the Test

In this section, the correlations between the scores of each of the tasks in each section as well as the correlations between the scores of each task and the scores of the total of each of sections A and B as well

TABLE XVI

PERCENTAGE OF SUBJECTS OBTAINING SCORES OF ZERO, THREE, SIX, NINE, AND TWELVE ON TASK IX--SYMBOL IDENTIFICATION

Grade	Scores				
	0	3	6	9	12
One	5	10	5	35	45
Two	0	5	20	25	50
Three	0	10	15	20	55
Four	0	0	0	35	65
Five	0	0	10	5	85
Six	0	5	0	20	75
Total (N = 120)	0.83	5.00	8.33	23.33	62.50

as their combined total will be examined and discussed.

Pearson product-moment correlation coefficients were determined for each task with every other task, for each task with the total of each of sections A and B, and each task with the combined total of sections A and B. In addition, the intercorrelations between each section as well as each section and the combined total of sections A and B are also presented. These intercorrelations are presented in Table XVII.

It should be noted that any interpretation of the intercorrelations should recognize that the method of scoring (see Chapter III) was such that the scores for tasks 1 and 4, although really dichotomus because of the right or wrong answer possibility, appeared as though they were on a zero to twelve continuum. This method of scoring would somewhat inflate the correlations but tended to be compensated for by the fact that only those correlations which were significant at the .01 level were accepted.

A study of Table XVII indicates that task I was significantly correlated at the .01 level of significance with the total score for section A and the combined scores of sections A and B. That the ability to select the correct one of six photos representing a specific view of a model was not significantly correlated with any of the other individual tasks indicates that task I may be measuring an ability which was different from those in each of the remaining tasks.

Further study of Table XVII indicates that task II was significantly correlated with all of the tasks with the exception of tasks II and IV, as well as the section scores. This suggests that these tasks were probably measuring a common element.

TABLE XVII

INTERCORRELATIONS OF THE TASKS AND SECTIONS A AND B

OF THE BASE AREA SYMBOLS TEST

	Tasks and Sections											
	1	2	3	4	5	A	6	7	8	9	B	A&B
1	1.000	0.168	0.165	0.135	0.232	0.595*	0.145	0.158	0.185	0.045	0.154	0.498*
2		1.000	0.823*	0.248	0.382*	0.645*	0.485*	0.547*	0.494*	0.412*	0.567*	0.714*
3			1.000	0.311*	0.420*	0.678*	0.472*	0.500*	0.451*	0.420*	0.541*	0.726*
4				1.000	0.528*	0.707*	0.180	0.189	0.189	0.223	0.229	0.605*
5					1.000	0.746*	0.258*	0.293*	0.300*	0.225	0.315*	0.670*
A						1.000	0.396*	0.432*	0.423*	0.337*	0.465*	0.922*
6							1.000	0.926*	0.921*	0.338*	0.925*	0.683*
7								1.000	0.945*	0.389*	0.948*	0.725*
8									1.000	0.348*	0.933*	0.712*
9										1.000	0.619*	0.514*
B											1.000	0.770*
A&B												1.000

*Significant at the .01 level ($r \geq .254$).

Task III was significantly correlated with each of tasks, IV, V, VI, VII, VIII, and IX as well as the scores of sections A and B and their combined scores. There was significant positive correlation between the scores of tasks IV and V. This indicates that subjects who were able to select one of the cards as being the correct map could likely draw the correct map and vice versa. In addition task IV was also significantly correlated with the total score for section A and the combined scores of sections A and B. The scores of task V were significantly correlated with the scores for each of sections A and B, their combined scores, and tasks VI, VII, and VIII.

The total scores of section A were significantly correlated at the .01 level of significance with tasks VI, VII, VIII and IX as well as the total scores for section B and the combined score of sections A and B. This in effect meant that the five tasks of section A combined were measuring something similar to each of the tasks of section B as well as the combined section B.

Tasks VI, VII, VIII, and IX were significantly correlated at the .01 level with each other and with the scores for section B as well as the combined scores of sections A and B. Study of Table XVII indicated that the correlations for each of these tasks, with the possible exception of task IX, were very high. This probably suggests that the tasks of section B were of similar difficulty. It is noted that the intercorrelations among tasks VI, VII, and VIII were almost identical.

Thus it would appear that all tasks with the exception of tasks I and IV measured the same aspect of base area symbolization. However, scores

of tasks I and IV were significantly correlated with the total score for section A and the total test.

An Analysis of the Results in Terms of the Hypotheses

This section will present the results of the study and will outline the statistical procedures which were used to determine the relationship between the test scores and such factors as sex, socio-economic status, chronological age, intelligence, grade level, and recent air travel experience.

Hypothesis I

There is no significant correlation between the ability of males and females to represent three dimensional objects by the use of base area symbols as measured by the Base Area Symbols Test.

To test this hypothesis, the intercorrelation of each subject's sex and the scores obtained by the subject on each of tasks I to V as well as the total for section A were calculated by use of biserial correlation coefficients. The resulting correlations are presented in Table XVIII.

A study of Table XVIII indicated that there was no significant correlation at the .01 level of significance between sex and any of the task scores or the total score. Therefore, this hypothesis was accepted.

Hypothesis 2

There is no significant correlation between socio-economic status and the ability to represent three dimensional objects by the use of base area symbols as measured by the Base Area Symbols Test.

Pearson Product-Moment correlations were calculated between each subject's socio-economic status and the scores obtained by the subject on each of tasks I to V as well as the total for section A. The correlations are presented in Table XIX.

TABLE XVIII

CORRELATIONS OF SCORES OF TASKS I - V

IN SECTION A WITH SEX

	Tasks I - V and Total	Correlation With Sex
I	Photo Identification	0.138
II	Three-Dimensional Symbols	0.124
III	Two-Dimensional Symbols	0.102
IV	Map Selection	0.106
V	Map Drawing	0.062
	Total Section A	0.082

NOTE: $r \geqq .254$ at the .01 level of significance

TABLE XIX

CORRELATIONS OF SCORES OF TASKS I - V IN

SECTION A WITH SOCIO-ECONOMIC STATUS

	Tasks I - V and Total	Correlation With S.E. Status
I	Photo Identification	0.345*
II	Three-Dimensional Symbols	0.152
III	Two-Dimensional Symbols	0.192
IV	Map Selection	0.089
V	Map Drawing	-0.115
	Total Section A	0.235

Note: $r \geq .254$ at the .01 level of significance.

Study of Table XIX revealed that there was no significant correlation at the .01 level of significance between the subjects' socio-economic status and the task scores, except task I, or the total score. This hypothesis was accepted.

Hypothesis 3

There is no significant correlation between chronological age and and ability to represent three dimensional objects by the use of base area symbols as measured by the Base Area Symbols Test.

Intercorrelations were determined between the chronological ages of the subjects and the total scores on each individual task of section A as well as the total score. The correlations are presented in Table XX.

Study of Table XX revealed that chronological age was correlated at the .01 level of significance with the children's ability to represent three dimensional objects by the use of base area symbols as measured by the Base Area Symbols Test. Chronological age was significantly correlated with all individual tasks of section A as well as the total for section A. Therefore, this hypothesis was rejected.

Hypothesis 4

There is no significant correlation between intelligence and the ability to represent three dimensional objects by the use of base area symbols as measured by the Base Area Symbols Test.

Intercorrelations were determined between the intelligence of the subjects and the total score of section A as well as each individual task in the section. These correlations are presented in Table XXI.

Study of Table XXI revealed that intelligence was correlated with the total score obtained on section A of the Base Area Symbols Test as

TABLE XX

CORRELATIONS OF SCORES OF TASKS I - V

IN SECTION A WITH CHRONOLOGICAL AGE

	Tasks I - V and Total	Correlation With C.A.
I	Photo Identification	0.316*
II	Three-Dimensional Symbols	0.354*
III	Two-Dimensional Symbols	0.334*
IV	Map Selection	0.339*
V	Map Drawing	0.537*
	Total Section A	0.552*

NOTE: $r \geqq .254$ at the .01 level of significance.

TABLE XXI

CORRELATIONS OF SCORES OF TASKS I - V

IN SECTION A WITH INTELLIGENCE

	Tasks I - V and Total	Correlation With Intelligence
I	Photo Identification	0.411*
II	Three-Dimensional Symbols	0.413*
III	Two-Dimensional Symbols	0.392*
IV	Map Selection	0.358*
V	Map Drawing	0.329*
	Total Section A	0.566*

NOTE: $r \geq .254$ at the .01 level of significance.

well as each task in section A. Therefore, this hypothesis was rejected.

Hypothesis 5

There is no significant correlation between grade level and the ability to represent three dimensional objects by the use of base area symbols as measured by the Base Area Symbols Test.

Intercorrelations between the grade level of the subjects tested and their scores on each of the tasks in section A as well as the total score were calculated to test this hypothesis. The results were tabulated in Table XXII.

Table XXII indicated that the grade level of children was significantly correlated at the .01 level with the total score obtained on section A of the Base Area Symbols Test and each of the tasks. As a result, this hypothesis was rejected.

Hypothesis 6

There is no significant correlation between recent air travel experience and the ability to represent three dimensional objects by the use of base area symbols as measured by the Base Area Symbols Test.

This hypothesis was tested by calculating the intercorrelations between recent air travel experience of the subjects and their scores on each task and the total scores on section A. The resulting biserial correlation coefficients are presented in Table XXIII.

A study of Table XXIII revealed that the recent air travel experience of subjects was not significantly related at the .01 level of significance with the scores obtained on any of the tasks or the total score of section A. Therefore, this hypothesis was accepted. However, the very small percentage

TABLE XXII

CORRELATIONS OF SCORES OF TASKS I - V

IN SECTION A WITH GRADE LEVEL

	Tasks I - V and Total	Correlation With Grade Level
I	Photo Identification	0.344*
II	Three-Dimensional Symbols	0.361*
III	Two-Dimensional Symbols	0.374*
IV	Map Selection	0.393*
V	Map Drawing	0.539*
	Total Section A	0.596*

NOTE: $r \geqq .254$ at the .01 level of significance.

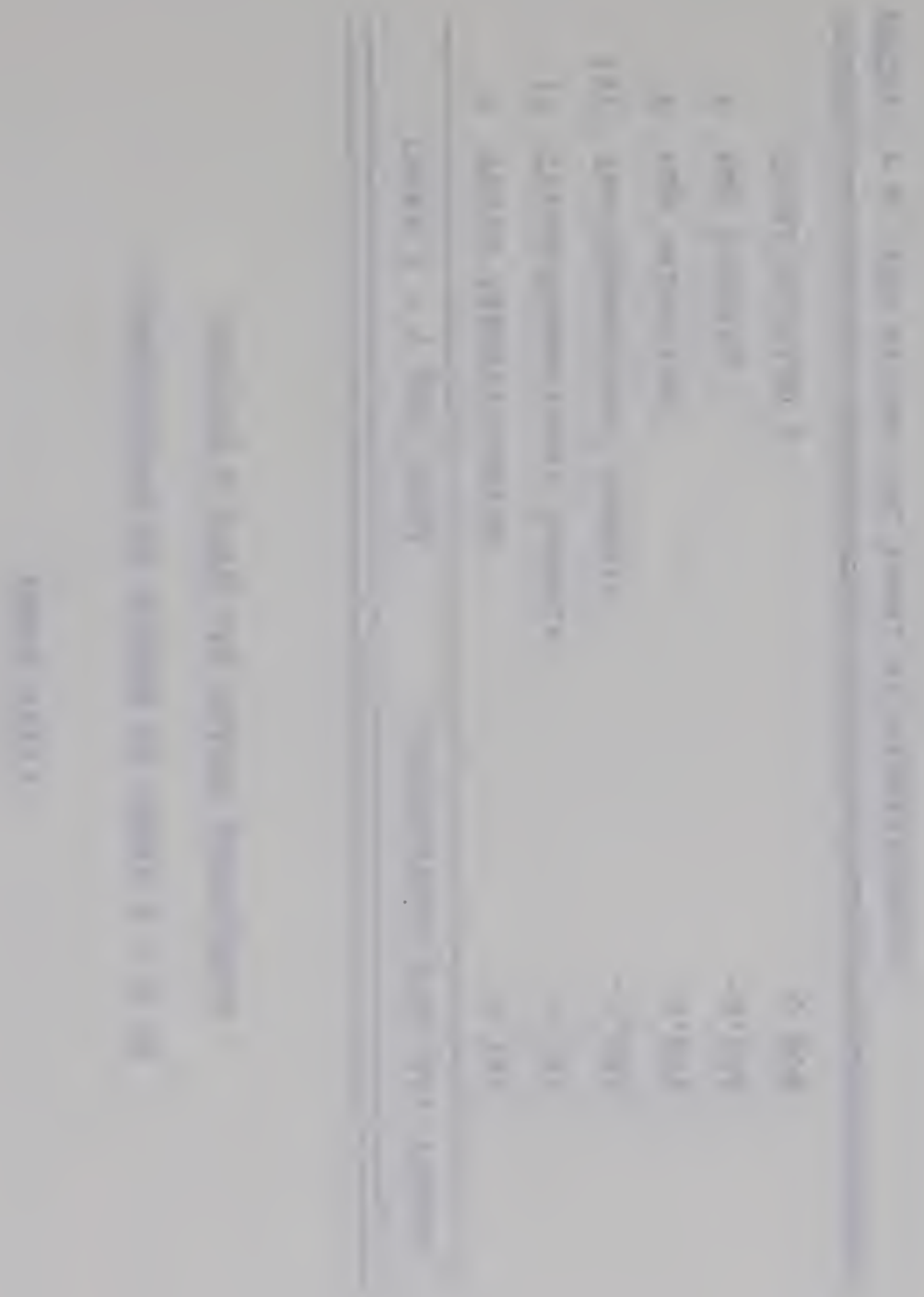
TABLE XXIII

CORRELATIONS OF SCORES OF TASKS I - V IN

SECTION A WITH AIR TRAVEL EXPERIENCE

Tasks I - V and Total		Correlation With Air Travel
I	Photo Identification	0.141
II	Three-Dimensional Symbols	0.026
III	Two-Dimensional Symbols	-0.085
IV	Map Selection	0.032
V	Map Drawing	-0.154
	Total Section A	0.008

NOTE: $r \geq .254$ at the .01 level of significance.



of subjects having travel by air would probably limit the value and reliability of this finding.

Hypothesis 7

There is no significant correlation between the ability of males and females to visualize objects represented by base area symbols as measured by the Base Area Symbols Test.

This hypothesis was tested by calculating the intercorrelations between sex and the scores obtained by the subjects on each of the tasks in section B as well as the total score in this section. The biserial correlation coefficients are presented in Table XXIV.

Study of Table XXIV indicated that sex was not significantly correlated with the scores on either the total score or the scores of any of the tasks in section B. Therefore, this hypothesis was accepted.

Hypothesis 8

There is no significant correlation between socio-economic status and the ability to visualize the objects represented by base area symbols as measured by the Base Area Symbol Test.

This hypothesis was tested by determining the biserial correlations between the socio-economic status of the subjects and their score on section B as well as each individual task. The correlations are presented in Table XXV.

An examination of Table XXV indicated that socio-economic status was not significantly correlated at the .01 level of significance with any of the task scores or with the section B total score. Therefore, this hypothesis was accepted.

TABLE XXIV

CORRELATIONS OF SCORES OF TASKS VI - IX

IN SECTION B WITH SEX

Tasks VI - IX and Total		Correlation With Sex
VI	Two-Dimensional Symbols	0.046
VII	Three-Dimensional Symbols	0.039
VIII	Real Objects	0.048
IX	Symbol Identification	0.111
	Total Section B	0.072

NOTE: $r \geqq .254$ at the .01 level of significance.

TABLE XXV

CORRELATIONS OF SCORES OF TASKS VI - IX IN

SECTION B WITH SOCIO-ECONOMIC STATUS

	Tasks VI - IX and Total	Correl. With Socio-Economic Status
VI	Two-Dimensional Symbols	0.121
VII	Three-Dimensional Symbols	0.124
VIII	Real Objects	0.057
IX	Symbol Identification	0.158
	Total Section B	0.137

NOTE: $r \geq .254$ at the .01 level of significance.

Hypothesis 9

There is no significant correlation between chronological age and the ability to visualize the objects represented by base area symbols as measured by the Base Area Symbols Test.

To test this hypothesis, intercorrelations were calculated between the chronological age of the subjects and their scores on section B as well as each task. The results are presented in Table XXVI.

Examination of Table XXVI revealed that chronological age was correlated at the .01 level of significance with the scores on each of the tasks as well as the total score for section B. Therefore, this hypothesis was rejected.

Hypothesis 10

There is no significant correlation between intelligence and the ability to visualize the objects represented by base area symbols as measured by the Base Area Symbols Test.

This hypothesis was tested by calculating the intercorrelations between the intelligence quotients of the subjects tested and the score on each of the tasks and the total in section B. The resultant correlations are presented in Table XXVII.

Examination of Table XXVII revealed that intelligence was significantly correlated with the scores on each of the tasks as well as the total scores for section B. Consequently, this hypothesis was rejected.

Hypothesis 11

There is no significant correlation between grade level and the ability to visualize the objects represented by base area symbols as measured by the Base Area Symbols Test.

TABLE XXVI

CORRELATIONS OF SCORES OF TASKS VI - IX

IN SECTION B WITH CHRONOLOGICAL AGE

Tasks VI - IX and Total		Correlation With C.A.
VI	Two-Dimensional Symbols	0.349*
VII	Three-Dimensional Symbols	0.344*
VIII	Real Objects	0.360*
IX	Symbol Identification	0.291*
	Total Section B	0.393*

NOTE: $r \geq .254$ at the .01 level of significance.

TABLE XXVII

CORRELATIONS OF SCORES OF TASKS VI - IX

IN SECTION B WITH INTELLIGENCE

	Tasks VI - IX and Total	Correlation With Intelligence
VI	Two-Dimensional Objects	0.304*
VII	Three-Dimensional Objects	0.297*
VIII	Real Objects	0.304*
IX	Symbol Identification	0.263*
	Total Section B	0.342*

NOTE: $r \geq .254$ at the .01 level of significance.

This hypothesis was tested by calculating the intercorrelations between the grade level of the subjects and their scores on each of the tasks and total score in section B. The correlations are presented in Table XXVIII.

A study of Table XXVIII revealed that grade level was significantly correlated at the .01 level with the scores of each of the tasks in addition to the total score on section B. Because of the significant correlation, this hypothesis was rejected.

Hypothesis 12

There is no significant correlation between recent air travel experience and the ability to visualize the objects represented by base area symbols as measured by the Base Area Symbols Test.

This hypothesis was tested by calculating the intercorrelations between the recent air travel experience of subjects with their scores on each task in this section as well as the total score for section B. The biserial correlations for air travel are presented in Table XXIX.

Perusal of Table XXIX revealed that there was no significant correlation between recent air travel experience of the subjects and their performance in section B of the Base Area Symbols Test. Consequently, this hypothesis was accepted.

Hypothesis 13

There is no significant correlation between the total score obtained by each subject on section A of the Base Area Symbols Test dealing with the representation of three dimensional objects by the use of base area symbols and the total score obtained by each subject on section B of the same test dealing with the visualization of objects represented by base area symbols.

TABLE XXVIII

CORRELATION OF SCORES OF TASKS VI - IX

IN SECTION B WITH GRADE LEVEL

	Tasks VI - IX and Total	Correlation With Grade Level
VI	Two-Dimensional Symbols	0.381*
VII	Three-Dimensional Symbols	0.364*
VIII	Real Objects	0.368*
IX	Symbol Identification	0.277*
	Total Section B	0.406*

NOTE: $r \geqq .254$ at the .01 level of significance.

TABLE XXIX

CORRELATIONS OF SCORES ON TASKS VI - IX

IN SECTION B WITH AIR TRAVEL

Tasks VI - IX and Total		Correlation With Air Travel
VI	Two-Dimensional Symbols	-0.062
VII	Three-Dimensional Symbols	-0.014
VIII	Real Objects	-0.054
IX	Symbol Identification	-0.099
	Total Section B	-0.068

NOTE: $r \geq .254$ at the .01 level of significance.

This hypothesis was tested by calculating the intercorrelations between the total scores obtained by subjects on section A with the total scores obtained on section B and the total for both sections. In addition, the intercorrelation between the scores obtained on section B and the total of both sections A and B was calculated. The correlations are presented in Table XXX.

Study of Table XXX revealed that the scores obtained on section A were significantly correlated at the .01 level of significance with the scores obtained on section B as well as the total score for section A and B. In addition the scores obtained on section B were significantly correlated with the total score obtained on sections A and B. Therefore, this hypothesis was rejected.

Additional Analyses

There was found to be a significant correlation between the grade level of children and the development of the concept of base area symbols. This relationship was examined more closely with a view to verifying the research hypotheses stating that there is a sequence of development in the ability of children to represent three dimensional objects by use of base area symbols and to visualize objects represented by base area symbols. Means and standard deviations calculated for each task and each section score are presented in Table XXXI. A study of Table XXXI revealed that, with several exceptions, there was a gradual increase in the mean score of each of the tasks through the grades from one through six. The mean scores for each of sections A and B as well as total test were plotted by grade

TABLE XXX

INTERCORRELATIONS OF SCORES OF

SECTIONS A, B, AND A+B

Sections	Sections		
	A	B	A+B
A	1.000	0.465*	0.922*
B		1.000	0.770*
A+B			1.000

NOTE: $r \geq .254$ at the .01 level of significance.

TABLE XXXI

MEANS AND STANDARD DEVIATIONS OF TASKS AND SECTIONS BY GRADE

Grade	1		2		3		4		5		6	
Means & Std. Dev.	M	S.D.	M	S.D.	M	S.D.	M	S.D.	M	S.D.	M	S.D.
Task I	4.80	5.88	4.80	5.88	8.40	5.50	8.40	5.50	8.40	5.50	10.80	3.60
Task II	8.30	3.42	8.30	2.53	9.75	3.27	10.80	1.50	10.75	1.97	10.80	2.36
Task III	8.05	2.94	7.15	3.20	8.95	2.84	10.20	2.01	10.05	1.99	10.45	2.31
Task IV	1.80	4.28	1.80	4.28	3.00	5.20	3.00	5.20	6.00	6.00	8.40	5.50
Task V	2.95	3.47	3.55	3.09	4.40	3.02	6.65	3.80	7.65	3.79	9.50	4.17
Sec. A	26.00	16.06	25.60	8.46	34.50	13.85	39.55	10.38	42.85	9.25	49.95	8.67
Task VI	8.35	3.45	9.00	2.45	10.20	2.50	11.30	1.19	10.60	2.03	11.15	1.46
Task VII	8.15	3.34	9.35	2.39	10.10	2.96	11.35	0.65	10.45	2.20	11.10	1.51
Task VIII	8.50	3.37	9.60	2.35	10.10	2.59	11.35	0.91	10.65	1.80	11.30	1.42
Task IX	9.15	3.48	9.60	2.78	9.60	3.09	10.95	1.43	11.25	1.87	10.95	2.18
Sec. B	34.15	12.08	37.55	8.60	40.00	9.38	44.95	2.78	42.95	5.76	44.50	4.50
Sec. A&B	60.15	23.36	63.15	13.95	74.50	19.32	85.00	10.90	85.80	11.76	94.45	11.28

level in Figure 14 in order to show the relationship between the test scores and the grade level. Examination of Figure 14 indicated that there was a sequence of development through grades one through six in the ability of children to represent three dimensional objects by use of base area symbols (section A). Except for a very slight drop after the grade four level, there was also a sequence of development through the grades in the ability of children to visualize objects represented by base area symbols (section B). Further examination of Figure 14 indicated that when the means of the combined sections A and B were plotted, there was an indication of a definite sequence of development in the ability to use and understand base area symbols in grades one through six.

In an effort to verify the research hypothesis that children are able to represent three dimensional objects by use of base area symbols at an earlier stage than they are able to visualize the objects that are represented by the base area symbols, the mean of each task in sections A and B was calculated for the total group. These means are presented in Table XXXII. In order that the means of the two sections could be compared more easily, they were plotted in Figure 15. From an examination of Table XXXII and Figure 15 it would appear that the latter part of the test, section B, dealing with the ability to visualize the objects that are represented by the base area symbols, was generally easier than the first part of the test dealing with the representation of three dimensional objects by the use of base area symbols. It should be remembered that the learning factor was accounted for by alternating the order of the tasks with

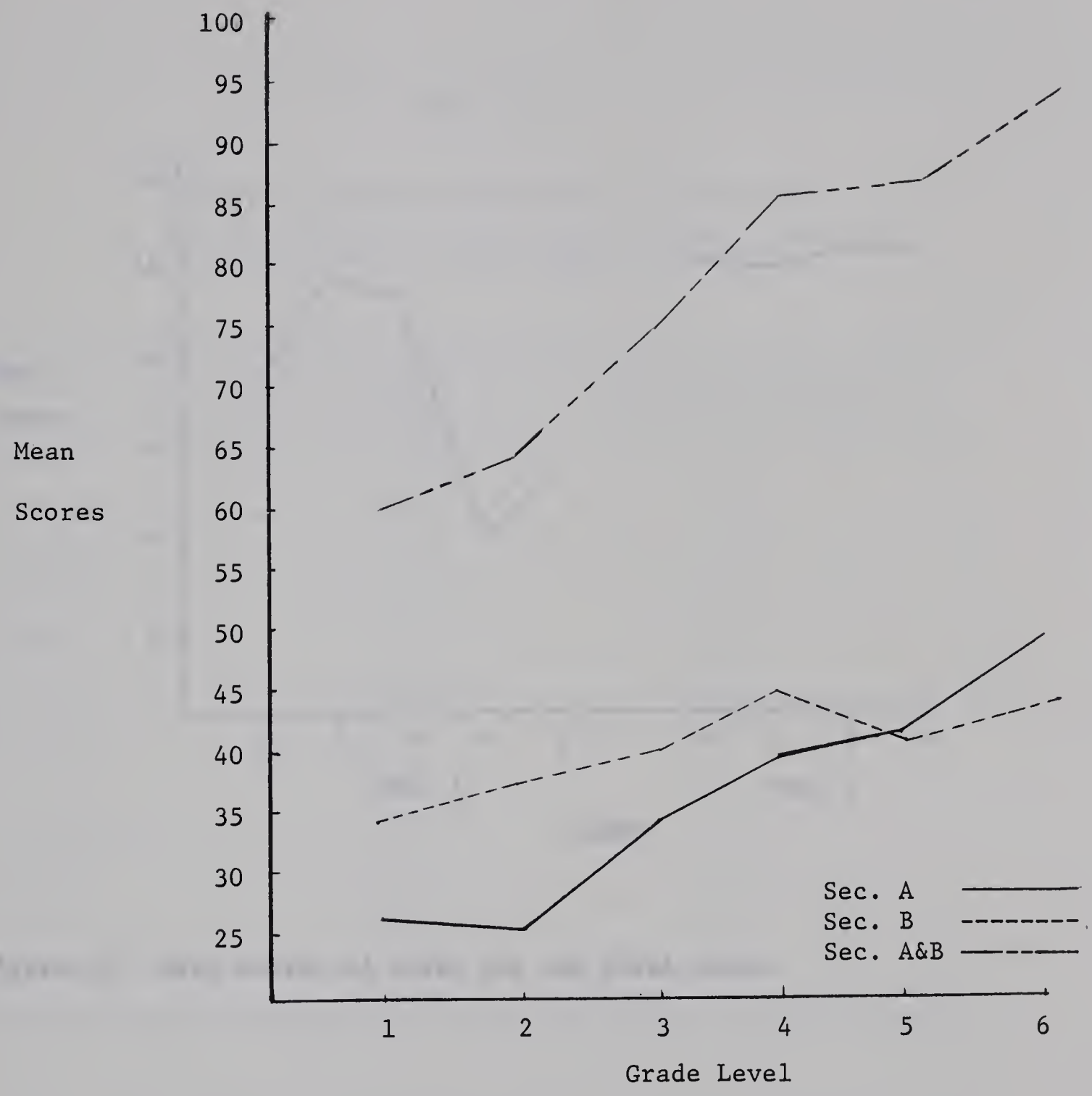
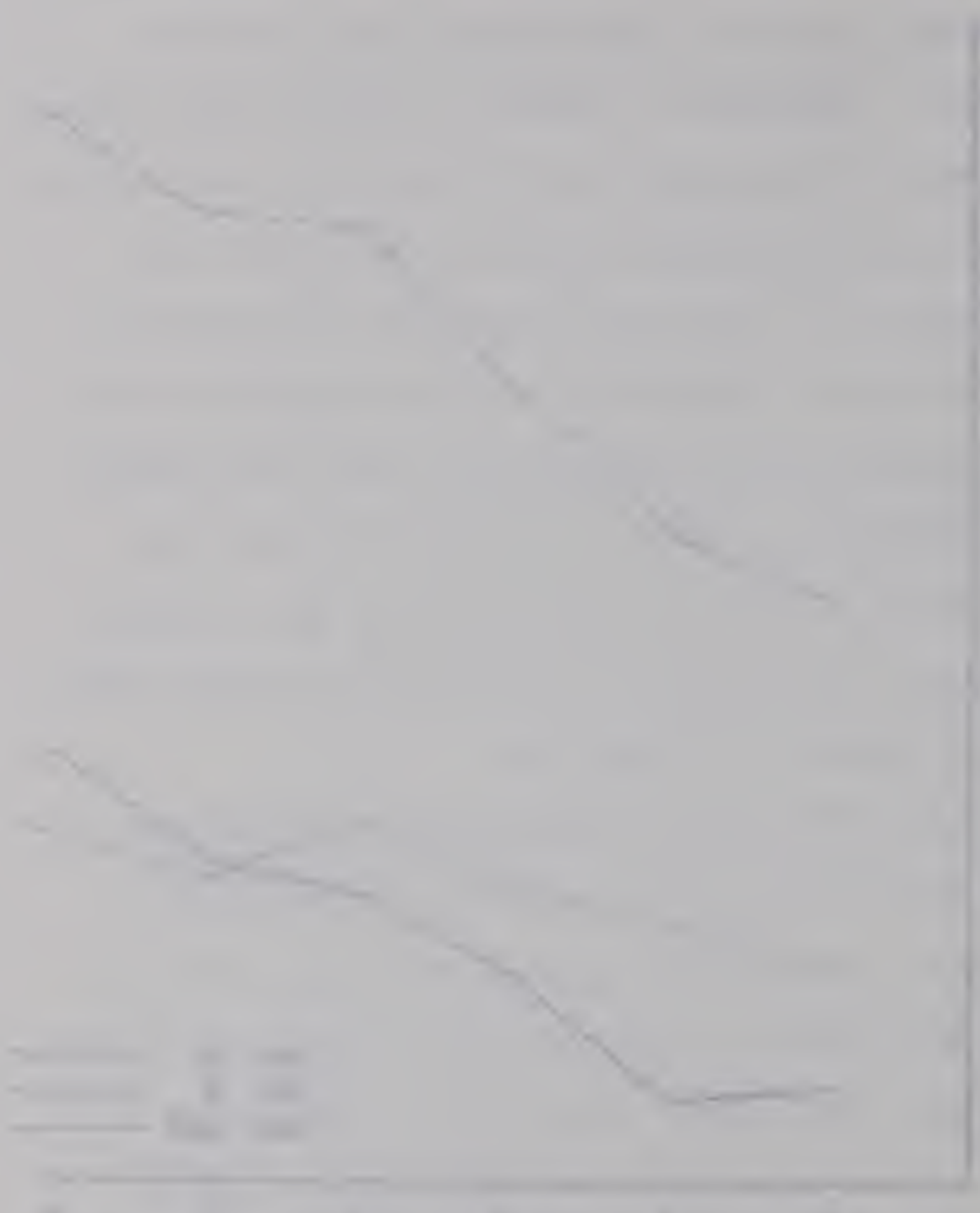


Figure 14. Mean Scores of Sections and Total by Grade Level.



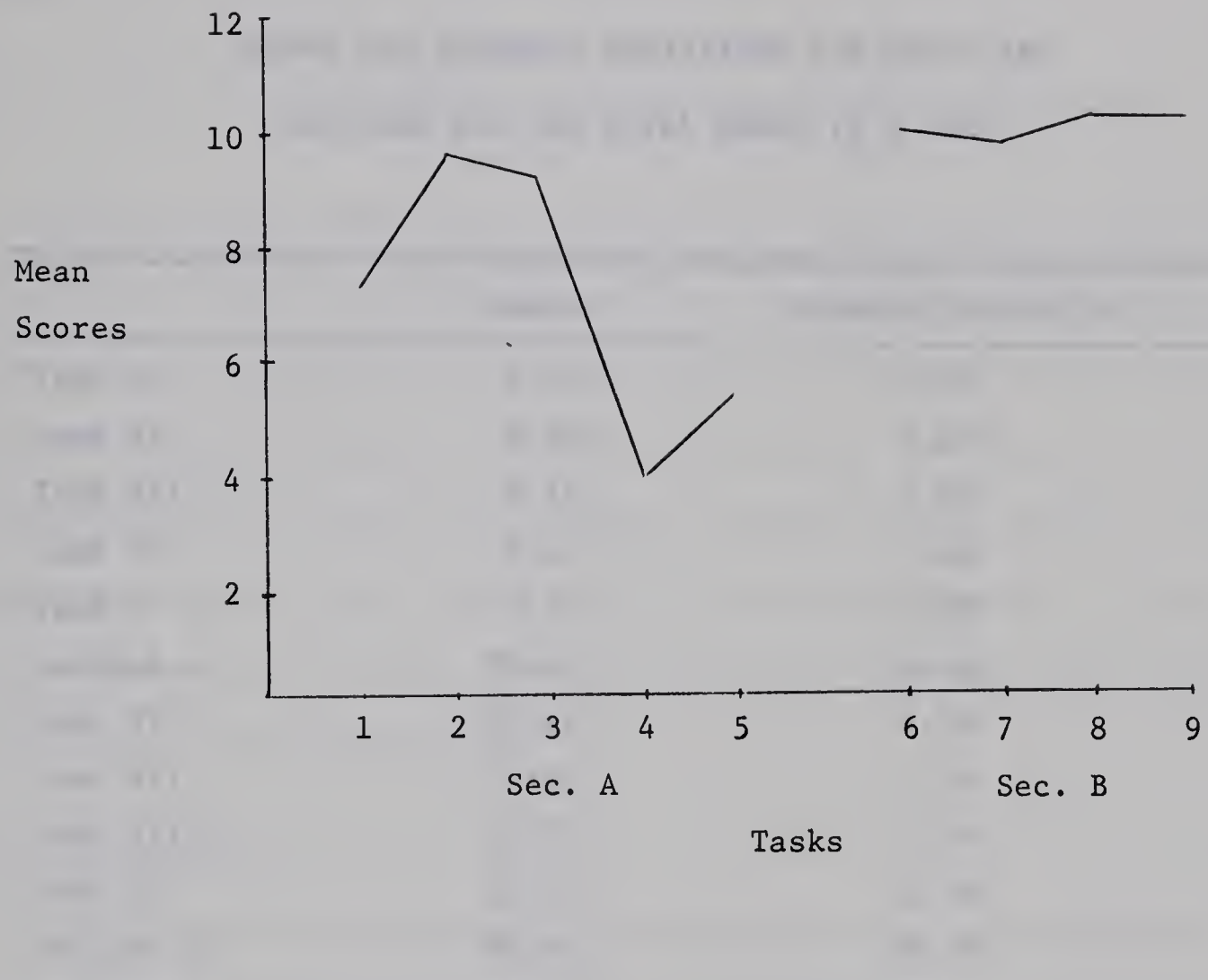


Figure 15. Mean Scores of Tasks for the Total Group.

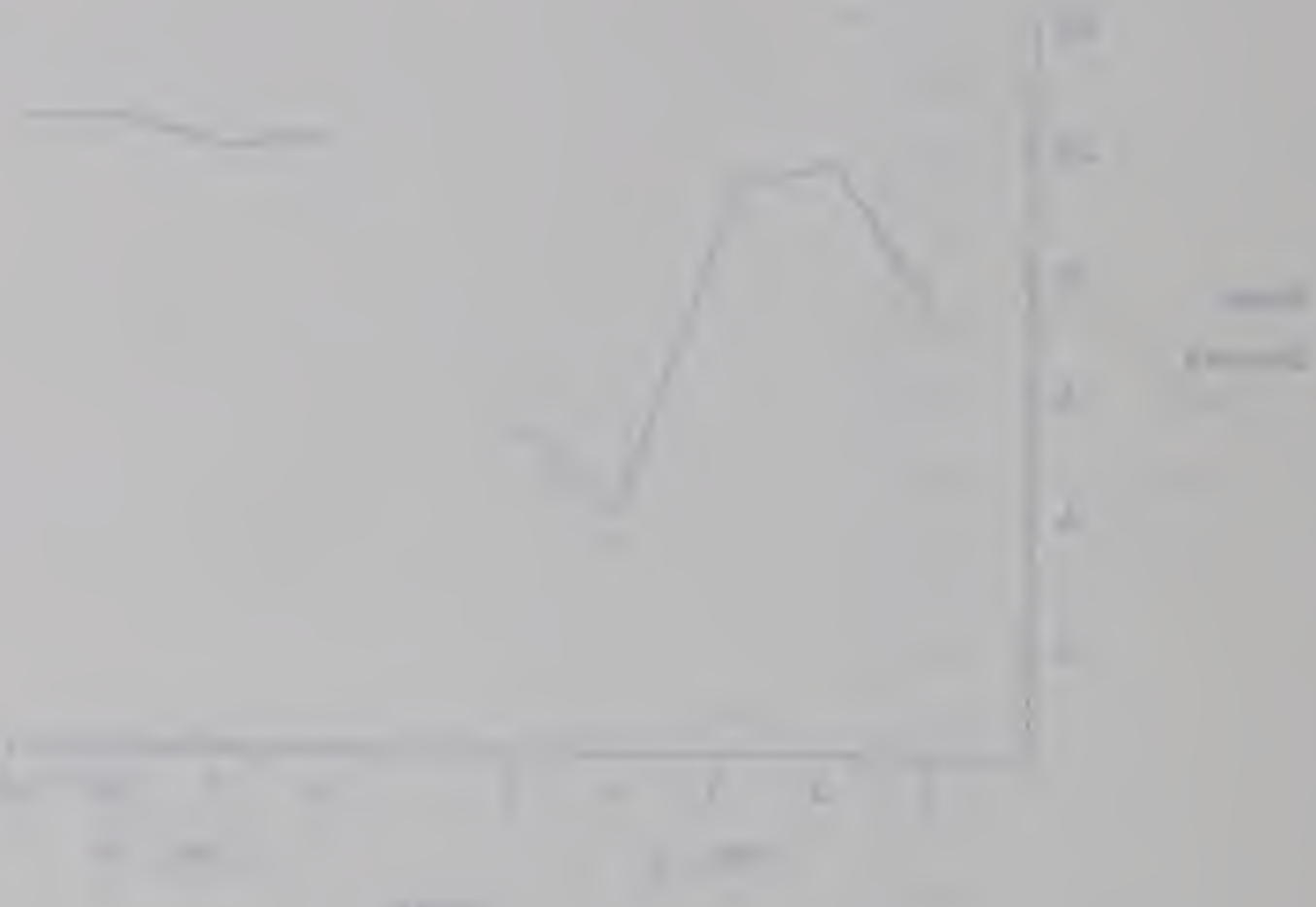


TABLE XXXII

MEANS AND STANDARD DEVIATIONS FOR TASKS AND SECTIONS FOR THE TOTAL GROUP (N = 120)

	Means	Standard Deviation
Task I	7.60	5.78
Task II	9.78	2.83
Task III	9.14	2.86
Task IV	4.00	5.66
Task V	5.78	4.28
Section A	36.41	14.45
Task VI	10.10	2.55
Task VII	10.08	2.59
Task VIII	10.25	2.44
Task IX	10.25	2.70
Section B	40.68	8.76
Sections A and B	77.17	20.11

every other subject. However, it is evident that more carefully structured research dealing with this aspect is required before this hypothesis can be verified or rejected.

III. SOME OBSERVATIONS BASED ON THE TESTING SITUATION

The Base Area Symbols Test, administered individually to the sample of one hundred twenty, required the subjects to perform various tasks involving maps, photographs, and map symbols. While each subject was at work, the examiner was able to record observations which may be of value in understanding more about the problems involved in map reading, particularly the reading of map symbols. While these observations are entirely non-objective, they are summarized here in order to enlarge upon the results reported in the previous section.

General Observations

When the subjects entered the testing room they were invited to observe carefully the model town that was displayed on the table. Many of the children, especially the boys in the lower grades, appeared fascinated by the model and expressed a desire to play on the streets with the cards. Approximately a third of the sample crouched down so that the "town" was at eye level in order to see how the buildings and trees were made. Others expressed a desire to look at it from a closer distance or from the other side. The latter requests were refused because all subjects were to view the model from a maximum forty-five degree angle before testing began. Most of the children commented that this test was different from any they had

ever taken and even expressed a desire to come back again after the testing was over. One boy expressed some of the enthusiasm for the test when he said, "I wish more of the tests were like this. This is fun!"

Photograph Identification (Task I)

When the various subjects were presented with the task of selecting the photograph which could have been taken from directly above the model town some of the children immediately responded by pointing to a photograph that was nearest to them but then almost as immediately indicated that they wished to think about their choice. After a second look at the photographs a substantial number of subjects changed their response. Other subjects were very hesitant. Some studied the photographs carefully, went back for another look at the model, and then rechecked the photographs to finalize the decision. On the other hand, there were subjects at all grade levels who glanced at each photograph and immediately pointed to the correct vertical photograph. These children also had a ready reply to the question as to why they selected the photograph as being the right one. Typical replies are listed below. Numbers in brackets indicate grade level.

Robbie (I). "You would be able to see the roof tops. The others aren't right because you wouldn't be able to see the sides from up there."

Russell (II). "The centre is the same as the model."

Allen (III). "The roofs are facing up so that's what you would see."

Denise (IV). "It would have to be a small picture."

Lorraine (V). "If you were up above the town you wouldn't be able to see the sides of the buildings."

Tim (III). "It's just a guess!"

In general, the subjects who selected the correct vertical photograph were able to suggest that the sides of buildings wouldn't be seen and that the roof tops would be entirely visible.

However, as indicated in the previous section, almost thirty-five percent of the sample did not select the correct photograph. Some of the subjects centred on one item or type of item on the model and used it as a basis for the photograph selection. A number of children used the trees nearest to them on the model as a guide to photograph selection. Some of them actually counted the trees they could see on the model and then looked for a photograph that had an equal number. A few boys used the three cars on one block as a guide to selecting the correct photograph. Merrill in grade three, for example, chose the photographs representing the horizontal view of the model and muttered, "There are three cars in this parking lot and there are three cars in this photograph so this must be it."

Eight of the nine subjects who chose photographs one or four admitted that they were guessing at the correct choice. The other child pointed at the correct photograph and remarked, "That can't be the right picture because there are no houses in it."

The results of this task presented in a previous section indicated that the percentage of children selecting the correct photograph increased through the grades from one to six and that it was not until after grade three that more than half of the subjects were able to identify the correct photograph. The mean chronological age for the grade three sample

was 8.83 years. Piaget found that at the early stages of development, the egocentrism of the child predominated and it was not until stage IIIB that the child was able to visualize a perspective other than his own. The ages of children in Piaget's stage IIIB and that of this sample at the end of the third grade are very similar so that these observations are generally in agreement with Piaget's views.

Two and Three Dimensional Symbols, Scale Models (Tasks II, III, VI, VII, VIII)

The observations by the examiner regarding each of tasks II, III, VI, VII, VIII involving two and three-dimensional symbols and the scale models were so similar they will be treated together in this section. The problems encountered by the subjects in working these tasks were concerned mainly with selecting the correct block, selecting the correct size of symbol or model, and placing the symbols correctly on the block selected.

Over seventy percent of the subjects chose the correct block on which to place the symbols in tasks II and III, while approximately seventy-four percent of the sample selected the correct block for tasks VI, VII and VIII. For the former two tasks nearly twenty-six percent of the subjects simply worked on the block which was closest to them and the model. For the latter three tasks approximately seventeen percent of the sample used the block which was nearest to them and the map. Many of the subjects hesitated somewhat and compared the base with the model or the map in the latter tasks, before finally selecting the block but many of

the subjects just did not seem to think the location of the block was important at all. The majority of those who pondered before their decision chose the correct block. Some of the children started to place the symbols on a block which was incorrect but quickly changed to the correct block when they saw that they could not correctly place the symbols. Two children placed one symbol on each of the four blocks in each of the tasks involving placement of symbols and scale models. One third grade girl placed all of the available symbols at random all over the base using all four blocks.

The second major problem encountered by the subjects was that of selecting the correct size of symbol or model for each task. Most of the subjects would take a good look at the original model for tasks II and III, select a symbol, recheck its size and then place it on the base on the block they had selected. Various other approaches were used by some of the subjects. One boy at the first grade level lined up his two hands with a building on the model and then attempted to transfer his hands, kept the same distance apart, to the symbol. A number of the subjects took a symbol they had selected and held it up between themselves and the model and "sighted" to see if it was correct. One sixth grade boy viewed the model from various locations in an attempt to get the right size of symbol and place the symbols correctly. When attempting to find a two-dimensional symbol for the split-level house a number of the subjects selected a symbol, held it up before themselves, and "cut" it through the middle. One sixth grade girl explained this procedure by saying, "That's

the only way I can tell whether each half will be big enough for each level of the house." One fifth grade boy and one sixth grade boy each placed two cards, one overlapping the other, to get a split-level type symbol for the split-level. To represent the split-level house, one third grade girl placed a card four inches by five inches on the block and then placed a three-inch square card on top of it.

A very common error in selecting the correct size of symbol was the selection of over-size symbols. A number of subjects selected the three-inch by ten-inch card to represent the church which was three inches by six inches. Some used the six-inch square card to represent the three by six-inch buildings but the most common error was in selecting the symbol for the small three-inch square house. The majority of the subjects who selected an incorrect two or three-dimensional symbol for the three-inch square usually chose the symbol which was three by four inches. Others had difficulty finding any symbol that would represent a building. One third grade girl remarked, "There just isn't any block here that is as big as that church so I'll just leave it."

The third major problem encountered by the subjects in tasks II, III, VI, VII, and VIII was that of placing the symbols correctly on the block they had chosen. Many of the subjects, especially in the upper grades tested placed the symbols very accurately with little or no hesitation. However, a great number of the subjects, at the lower grades especially, placed the symbols in the correct general area and did not seem to be concerned about having symbols protrude over the edge of the diagonal,

or about having symbols not placed parallel to the side of the block as they should have been for three of the four symbols. Many of the younger children did not place the symbol for the church at a diagonal but rather placed it parallel to the side of the block.

It has already been noted that a substantial percentage of the subjects failed to select the correct block on which to place the symbols selected. The following two types of problems were noted in tasks II and III. In these two tasks the subjects were to use block three which had a diagonal cut in the far right-hand corner. Many of the subjects who used block four, having the diagonal in the far left-hand corner, placed the symbols in one or the other of the following ways. One method was apparently to imagine that the diagonal was in the far right-hand corner and to place the two or three-dimensional symbol for the church as if the diagonal were there. If the church was placed digaonally under the above circumstances, the symbol representing the rectangular building in the far left-hand corner was usually placed parallel to the far edge of the map and had one corner protruding over the edge of the diagonal. If block four was used, a second method was to place the church diagonally facing the cut at the corner and the other symbols accordingly. That is, the symbol for the split-level would then be placed in the near right-hand corner, the rectangular symbol in the far right-hand corner, and the square symbol in the near left-hand corner. This arrangement would create a mirror image. Children in the sample who placed the symbols according to either of these two methods did so with little confusion and appeared

to work as quickly as if nothing was wrong. However, one sixth grade girl used block four and could not determine why the symbol for the church did not appear correct when placed in the far right-hand corner. After trying for about fifteen minutes she asked whether she could proceed to the next task. In doing tasks VI, VII, and VIII she immediately selected the correct block and did not have any problem with placement of any of the symbols.

Map Selection (Task IV)

Only one-third of the total sample, sixty percent of which were at the grade five and six level, chose the correct map from the five cards presented. The major distractors were an oblique and a horizontal profile. The term "map" was not discussed with any of the subjects and it may be that they did not understand what to look for. There were a few individuals in the lower grades who replied negatively when asked whether they knew what a map was. This may partly account for the small percentage selecting the correct map.

Various types of reactions occurred following the instructions in this task. Some of the children, at the grades five and six level especially, took one quick look at the five cards and quickly eliminated, verbally, the three profiles as possible choices. This type of action occurred only occasionally at the lower grades. Many of the subjects were very hesitant on this task and appeared to be counting to themselves. When questioned about this counting the subjects indicated they were counting the number of tree symbols on each "map" to find one that had the same number of trees

as they counted on the block of the model. However, a substantial number of subjects selected the correct map very quickly. Some individuals were timed at less than twenty seconds. A number of children stood back at least ten feet to get a more horizontal view of the model before selecting a card. Two boys at the sixth grade level asked whether they could look at the model from above. When asked why they wished this view they explained that it would be necessary before they could be sure of the correct map. A large percentage of the children at the lower grades used the trees on the profiles as a guide to whether those cards were the correct map. They would count the number of trees on the profile that were visible and then compare with the number of trees on the model. Few of these subjects realized that not all of the trees were visible on the profile because they were behind the buildings.

Interesting and rather significant comments were made by some of the children when asked why they had chosen the correct map as the right one.

Robb (II). "If you laid this map (the correct one) over this block, it would be the same. There are the same number of trees and they're in the right place."

Brock (II). "When you go travelling and take a map with you, it just shows lines and roads. It does not show the buildings like these pictures."

William (I). "This is it because there are two trees, here, three trees there. . ." William chose the correct map by looking at the trees rather than the building symbols.

Donald (I). "Father lets me play with his maps when we play army so this is easy." Donald selected card one.[5]

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[5]See figure 8, Supra.

Peter (I). Immediately after hearing the instructions said, "It can't be those".[6] When asked why, he replied, "I can't make it out".

Wendy (III). "Number one[7] is not right because it's backwards. The others show pictures of buildings."

Nancy (V). "In a map, you don't draw the buildings. That's why this one is right."

Brian (V). "If you looked down on this block in your imagination this is what you would see."

Lynn (VI). "It appears to be that one. The others aren't really maps and that one[8] is turned around."

Jean (VI). "It's just a guess. I really don't know."

The preceding comments help to confirm that there were children throughout grades one to six who knew and some who did not know the difference between a map and a picture. As early as the second grade some children were able to indicate that the sides of buildings are not shown on maps. However, there were children, who as late as grade six, could not tell why one card was a map and why another wasn't. The comments also seem to indicate that some children benefit by travel on vacation where maps might be used to serve a practical purpose. Previous experience with maps probably prompted Brock to say that, ". . .it just shows lines and roads."

Map Drawing (Task V)

In the discussion of the test results in a previous section, three

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[6] See figures 8 and 11, Supra.

[7] See figure 8, Supra.

[8] See figure 11, Supra.

aspects--use of base area symbols, size of base area symbols, and orientation of the base area symbols--were considered in an objective manner. Many of the following observations are based partly on the drawings that the subjects made as part of the Base Area Symbols Test and partly on the observations of the investigator.

Subjects generally appeared to be as enthusiastic about doing this task as they had been about doing the map and photograph selection tasks. However, one girl at the grade six level refused to attempt to draw a map saying, "I don't know what it would look like." Three or four other children didn't seem to be sure of what they were doing so they stopped after they were about half finished. All others appeared to do their best.

A selection of materials was placed on the table adjacent to the work paper and the subjects were to use any of the materials they felt were needed. None of the subjects used the cardboard strips for measurement or drawing of lines. A few children used the ruler to help them draw straight lines. Some of the children used colored pencils which corresponded to the color of the roof tops and the trees but the majority of the subjects used an ordinary pencil for all of the drawing.

Although each "map" is a story in itself, most of the samples can be placed in one of four categories. A description of each category together with significant aspects and examples follows.

The first category includes "maps" such as that drawn by Kim, grade three, aged eight years nine months. (See Figure 16). In this category all or nearly all of the buildings are represented by profiles,

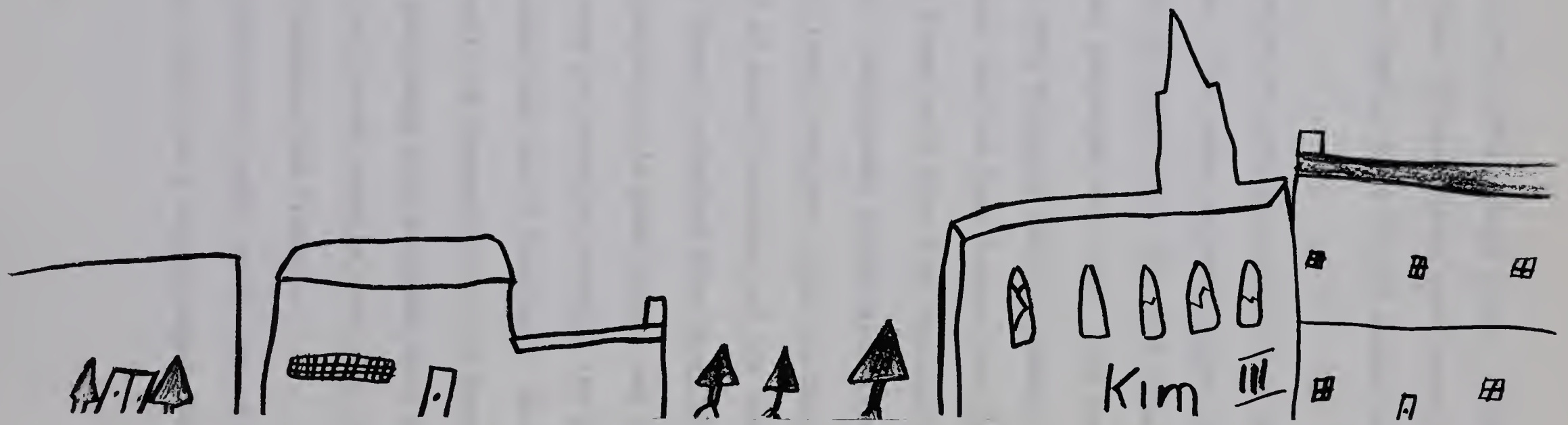


Figure 16. "Map" drawn by Kim, grade three.

rather than base area symbols, drawn along a base line. Fifteen subjects drew "maps" of this type. Of these fifteen there were seven at the grade one level, four at the grade two level, three at the grade three level, and one at the grade four level.

One boy at each of the grade one and two levels drew one large house in the center of the paper. Two trees colored bright green completed the pictures. One child at each of grades one, two, and three drew two buildings along the base line and completed the "map" with some carefully drawn trees. Each building was also equipped with a chimney. One "map" by a girl at the third grade level and one by a boy at the fourth grade level had profiles of buildings drawn on a base line but showed evidence that distance was to be included. Additional buildings were drawn in the background so that a near ground level resulted. The boy was careful to shade the roofs of the buildings to match the color of the buildings in the model. The eight remaining "maps" contained four profiles of buildings generally along a common base line which, in most cases, was along the bottom of the page. Two girls drew the profiles through the middle of the page and one boy drew his across the top of the page. In these eight samples the buildings were all small in comparison to the seven previously discussed. The outlines of the buildings were designed with windows of all shapes and sizes. The chimneys and church steeple were also included. A number of carefully drawn trees complete the drawings.

The second category included forty "maps" which showed buildings in profile, as in the first category, which were not arranged along a base line.

In some of the drawings the profiles were placed to match the block of the model but in others they were variously arranged. The "map" drawn by Darlene, a grade five student, aged ten years eight months was typical of this category. (See Figure 17.) Seven of the examples were drawn by grade one subjects, ten were from each of grades two and three, five were from each of grades four and five, and three were drawn by grade six subjects. Each of a number of different types of performance in this category is described below.

Twenty-two of the subjects drew "maps" which had four profiles of buildings placed approximately parallel to the sides of the paper. Most profiles were covered with windows and doors and the steeple or chimney was also present. Each subject usually included a number of trees. However, two of the subjects each drew two trees perpendicular to the left side of the "map". One child drew circles to represent the trees. Color was used by two persons. One girl colored the walls of the houses red while one boy very carefully shaded the roofs of the buildings he drew so they would match those of the model.

Twelve of the subjects drew "maps" with profiles which were very similar to those described in the previous paragraph. The major difference was that these children placed the profile of the church at a diagonal. However, none of these twelve drawings included the diagonal line itself which marked the outer limits of the block. Windows, doors, steeples, and trees were included. One child drew two trees perpendicular to the left side of the drawing. One child attached the steeple to the bottom of the church at the opposite end of the building.

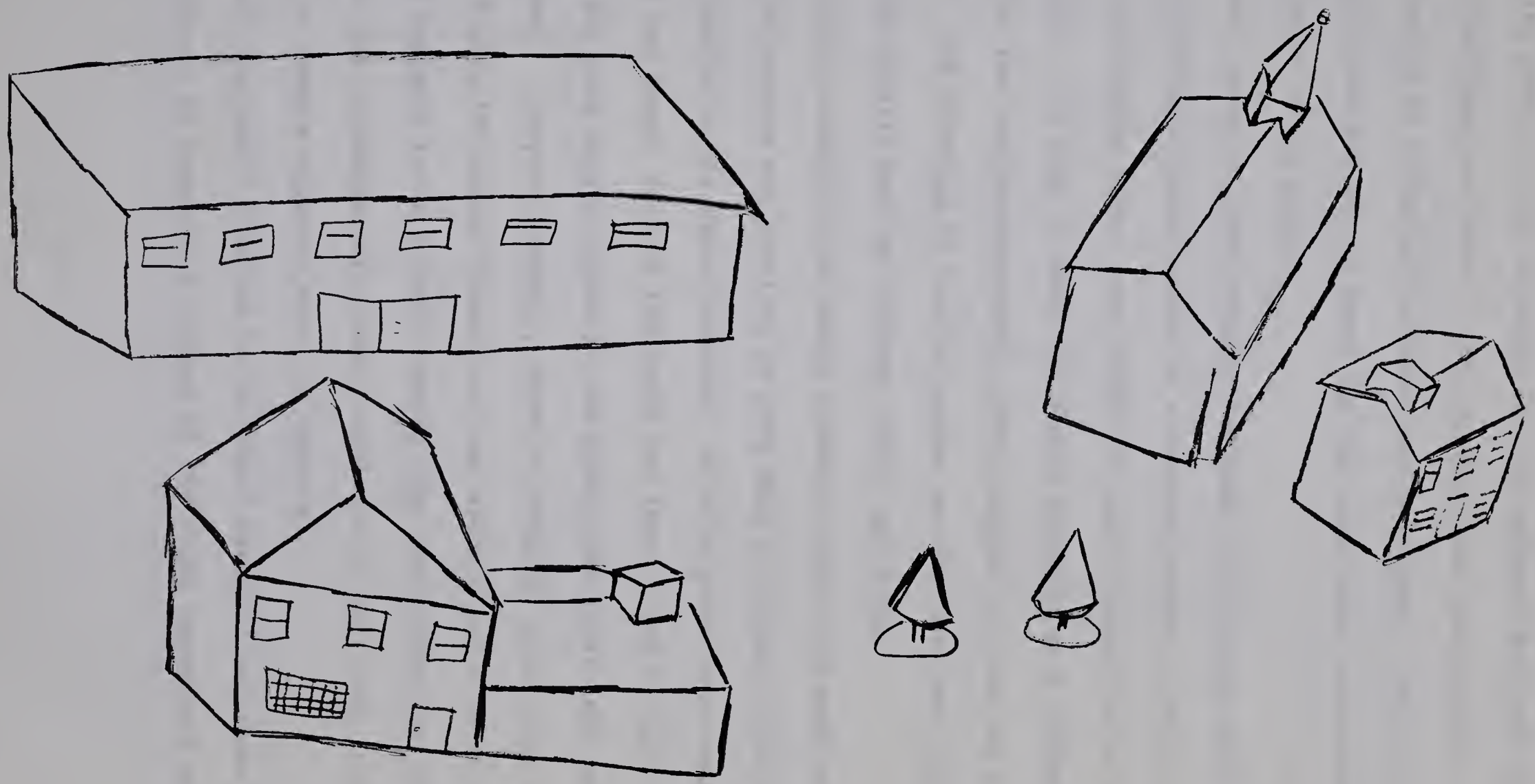


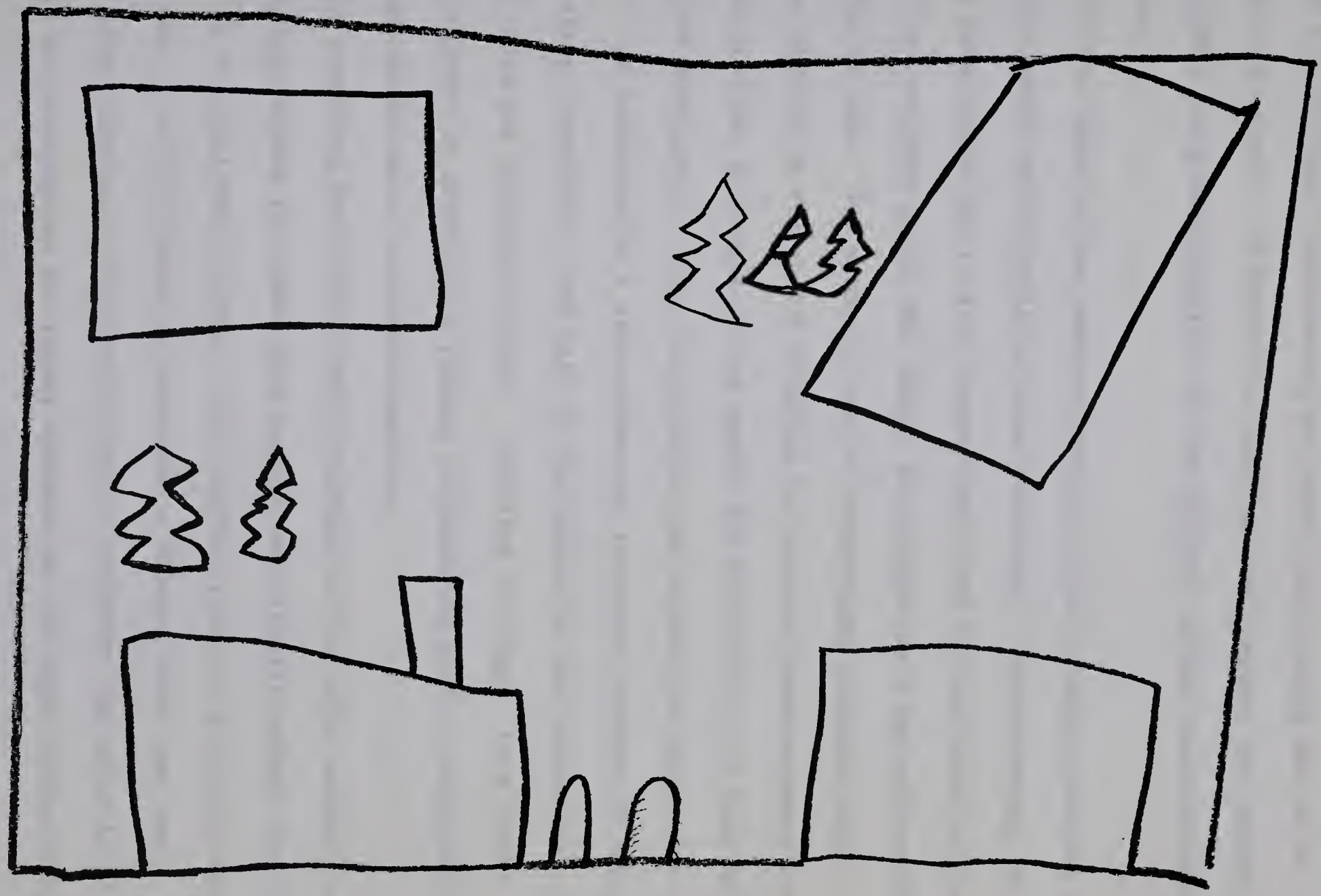
Figure 17. "Map" drawn by Darlene, grade five.

A third group of four drawings in this category had very small profiles of buildings in place of the required base area symbols. Three of these drawings by grade one children were very crude. Two of the four have included trees and one of these had the trees drawn perpendicular to the left side of the paper.

A fourth group in this category included two drawings which had profiles of buildings placed around in a circular manner. That is, the buildings very crudely drawn, were placed in such a manner as to create circular effect. In both of them, the church normally at a diagonal, was rotated to the left approximately ninety degrees so that the side view was exposed. The drawings by boys in grades two and four were also devoid of many of the details such as windows, doors, and trees.

In a third category were twenty drawings which were made up of a combination of symbols and profiles or were made of symbols which were not correctly oriented in the space provided. Of this group there were two at the grade one level, four at the grade two level, five at each of the grade three and five levels, three at the grade four level, and one at the grade six level. A typical example, drawn by Douglas, grade two, aged eight, (see Figure 18) showed three base area symbols and a fourth which probably was designed to be a symbol except that the chimney was added. An additional four drawings were almost identical in that they included a chimney or a steeple together with the symbols.

Five of the twenty drawings in the third category used base area symbols but showed an immaturity because of the crude appearance and the



Douglas II

Figure 18. "Map" drawn by Douglas, grade two.

improper placement of the symbols. The placement errors were generally confined to the symbol representing the model church which was to be placed at a diagonal. In these five drawings the diagonal was ignored or the symbol was placed parallel to the diagonal rather than perpendicular to it.

Another eight of the twenty drawings in this category combined base area symbols with profiles of some buildings. These drawings, by subjects from grades two to six, showed that there was confusion in the minds of the children as to what should be included in a map such as they were asked to draw. For example, four of these eight drawings showed base area symbols of the church building but each of these subjects included in profile, a steeple on the symbol for the church. In each of these eight drawings, at least one profile, and as many as three, was included. In a drawing by a sixth grade boy there was evidence of what Piaget called "rotation". One wall of the symbol for the church was "rotated" into the horizontal plane. According to Piaget, this characteristic appears in drawings of younger children who find it difficult to confine themselves to a single viewpoint.

The remaining two of the twenty drawings in the third category of "map" drawings showed four base area symbols and circular symbols for the trees. The diagonal was ignored. These drawings, one by a third grade girl and one by a fifth grade boy contained a feature which has been noted on other drawings. The symbols used to represent the split-level house were not rectangular but rather appeared in the shape of the side

wall. They were clearly intended to be base area symbols rather than profiles for they each contained a square, somewhat poorly placed, to represent the chimney. This error in symbol shape would appear to indicate some confusion in the ability of younger children to visualize something which cannot actually be seen.

Twenty-eight drawings can be placed in a fourth category which included maps which had all the correct elements including the use of symbols, proper orientation, and approximately correct size. An example of an almost perfect map was drawn by Jim, a sixth grade student, aged twelve years four months. (See Figure 19). One of the maps in this category was drawn by a first grade boy, six were drawn by each of grades four and five with grade six subjects drawing the remaining fifteen of the twenty-eight in this group. It would appear that the latter two categories of the four outlined, and particularly the last level of conceptualization are required before a child can be expected to work with the abstract symbols on a map with any success.

Of the twenty-eight maps in this fourth category there were three which showed evidence of the problem associated with the symbol for the split-level which was discussed in connection with the third category. In the previous section, the symbol was rectangular except for a rectangular portion added to one side of the rectangle so that the symbol became somewhat L-shaped. In the three examples in this category were symbols for the split-level which were enlarged in length and width for one-half of the symbol only. Thus the symbol had the appearance of a square fan with an attached handle. Conceivably this is the rotation of which Piaget speaks.

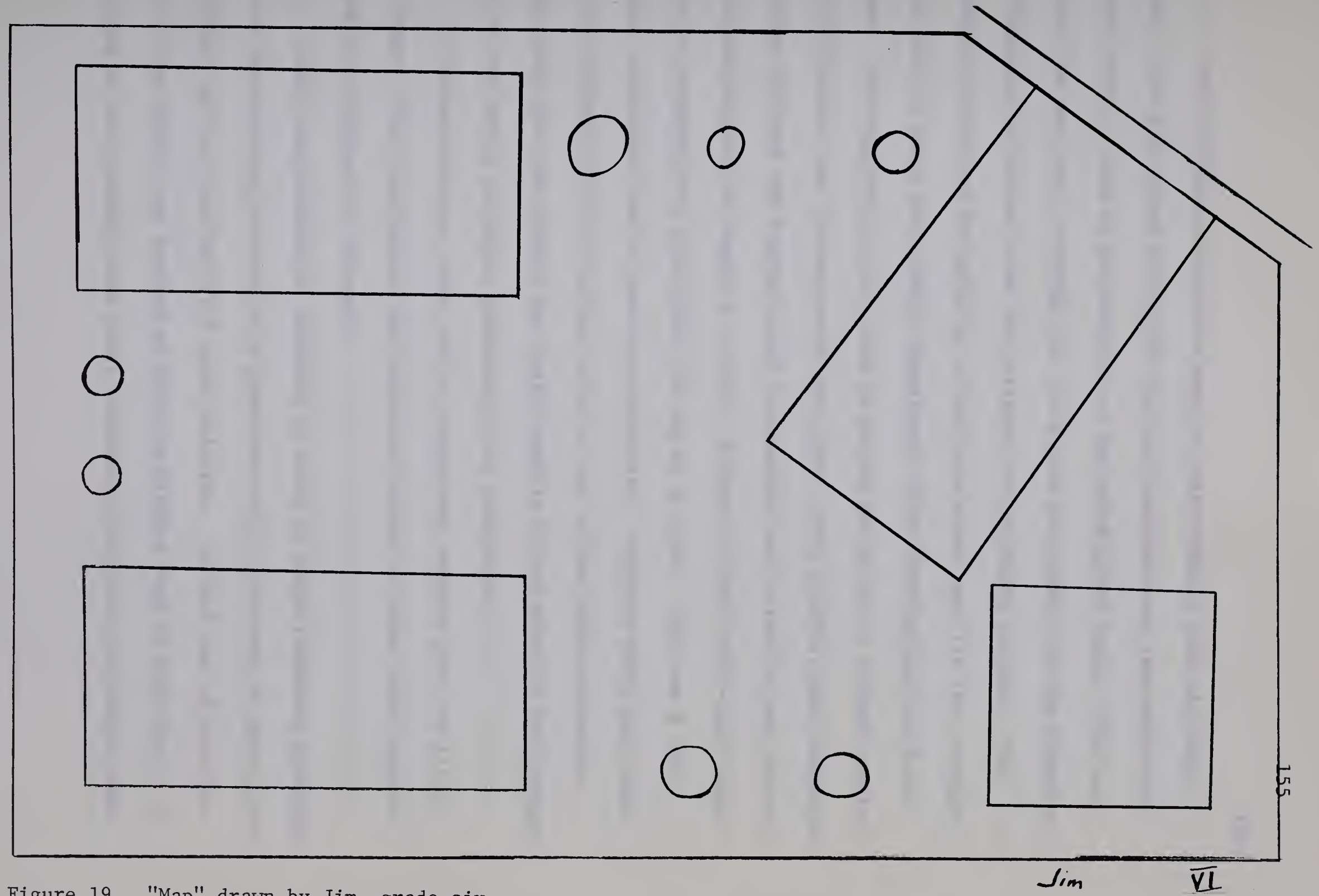
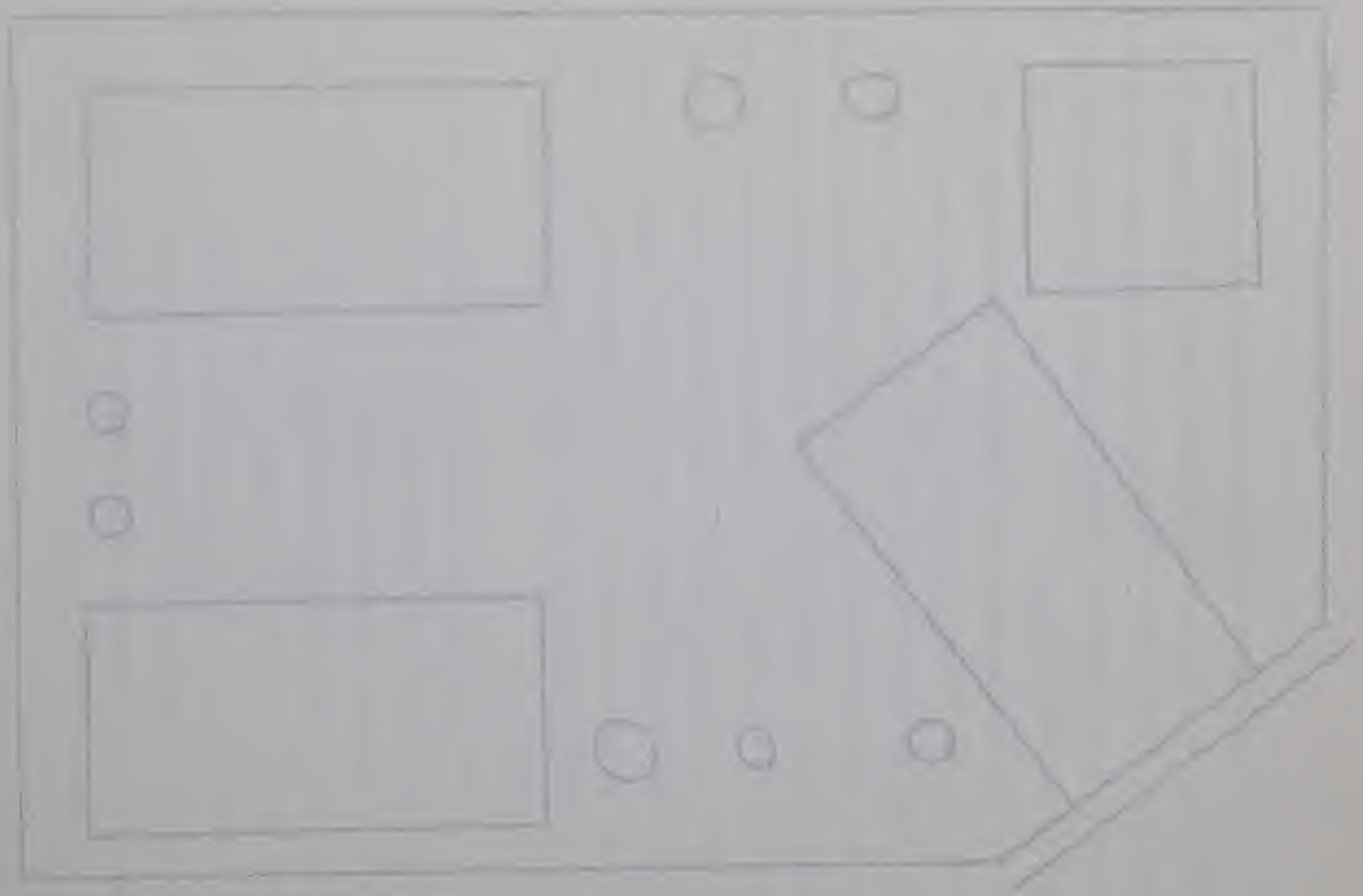


Figure 19. "Map" drawn by Jim, grade six.



The remaining twenty-five maps in this category were all well drawn. One map, drawn by a grade one boy, compared very favorably with those drawn by some of the subjects at the sixth grade level. The only major flaw was that, although the child drew the symbol for the church at a diagonal, he did not draw that diagonal on the block outline. The examiner noted that the majority of subjects whose maps fit this category were able to begin work almost immediately after instructions has been given. They appeared to know what to do and how to do it without pausing to think about what the map would look like. Once started, some completed the map in about two minutes while some worked very carefully and took up to fifteen minutes to complete the map. Fifteen of the twenty-eight maps in this category were drawn with the use of a ruler. This was a much higher proportion than in previous categories. Subjects whose maps made up this category did not use any color on any of the symbols possibly indicating that the symbols are really symbols in the minds of the subjects and do not merely represent drawings of the roof-tops.

Fifteen drawings could not be categorized because they had little in common. The investigator has discussed aspects of them which appeared to be of importance or interest.

There was evidence of rotation in seven of these remaining drawings. One of the drawings was that of a grade one child, four were by grade four children, and two were by fifth grade children. In each one of them one wall of the church was rotated so that the windows were in full view. In only one of the drawings were there buildings other than the church which

were rotated. One drawing, by a grade five boy had all walls of each of the four buildings rotated so that the roof and walls of each building were visible. In addition to the one rotated wall of the church, one drawing by a grade four boy showed at least two of the buildings lying parallel to the bottom of the map. They would appear upright if the paper were turned counterclockwise for ninety degrees.

A grade two boy produced a drawing which had four profiles, each with a roof that was colored to match those of the model. Two of the buildings, the church and the little square house in the bottom right-hand corner, were situated so that the page must be turned ninety degrees to a counter clockwise position so that they are upright. Two of the profiles were upright without turning the paper.

A third grade girl drew a map which contained four well placed base area symbols of nearly the correct size. She colored each one to match the roof tops of the buildings in the model. When questioned about the reason for using the color she replied that it was necessary in order to be able to tell which building she meant by each symbol.

One sixth grade boy drew four well placed base area symbols of almost exact size and then spent a number of minutes drawing careful profiles of the steeple and the chimneys on two other buildings. He also included lines to represent the peaks of the roof tops and the joints in the roofs of the plastic models.

One girl at the third grade level who had a low intelligence quotient drew very small profiles of each of the buildings and trees and

and then labelled each one a house, church or tree. She then began to draw a path from one house to the next. Each house had a door and two of the houses had chimneys and smoke both represented by a single line.

Two fifth grade boys drew maps which used base area symbols properly oriented. However, both of them drew an L-shaped symbol for the split-level house. In addition one of the two boys included some profiles of trees, two of which were drawn parallel with the bottom of the map. That is, the paper would have to be turned ninety degrees in a clockwise direction in order that the trees would be upright at the top of the map.

One second and one third grade girl carelessly drew profiles of the four buildings but they appeared to surround an imaginary center of the paper in a circular pattern. One of the drawings had the church and small house positions interchanged. The other had a five-sided wall to represent the large building to the left of the church.

The final "map" was drawn by a little Chinese girl in the first grade. She drew one large house in the middle of the paper. It had a door, two windows, and a chimney with a few wisps of smoke. However, the roof was typically Chinese with its fan-shaped shingles. She did not speak during the entire testing but understood directions because she made only two minor errors in tasks VI-IX.

Symbol Identification (Task IX)

Earlier in this chapter the results of this task were reported. It was indicated that over sixty-two percent of the total sample obtained the

maximum score of twelve for correctly identifying all four objects on a photograph which represented four different map symbols. One symbol from each of the four blocks was to be identified. The subjects who made errors in identification generally had difficulty in selecting the correct block or quadrant of the vertical photograph. Ten errors at each of the grade one, two and four levels, twelve errors at the grade three level, and four at each of the grade five and six levels, were attributed to the use of the incorrect block. That is, subjects pointed to a building on the photograph on a block other than the block on which the correct building was situated. In addition, four errors at the grade two level, three errors at the grades three and six levels, and one error at the fifth grade level, were made by identifying an incorrect building on the correct block. Children pointed to buildings which were beside the ones which would have been correct.

Many of the children identified the buildings on the photograph without hesitation. Others took a great deal of time and then usually made the errors that have been noted. One fifth grade boy indicated that he was not able to find one of the buildings and did not give a reply. One first grade boy, on the other hand, identified each symbol correctly and then quipped, "This is easy. All I did was count the trees and the buildings on the map and find the same number on the picture. That's how I found the building."

IV. SUMMARY OF THE FINDINGS

The principal findings of this study are summarized briefly.

1. There was no significant correlation between sex and the development of the concept of base area symbols.

2. There was no significant correlation between socio-economic status and the development of the concept of base area symbols.

3. There was a significant correlation between chronological age and the development of the concept of base area symbols.

4. There was a significant correlation between intelligence and the development of the concept of base area symbols.

5. There was a significant correlation between grade level and the development of the concept of base area symbols.

6. There was no significant correlation between recent air travel experience and the development of the concept of base area symbols.

7. The two sections of the Base Area Symbols Test were significantly correlated and would tend to be examining the development of the same concept.

8. It was not until the third grade that seventy percent of the sample could identify the photograph representing the "bird's eye view" of the model.

9. It was not until the fifth grade that at least fifty percent of the sample could identify the correct map of part of the model and only seventy percent of the sixth grade subjects could do so.

10. There was a sequence of development in the ability to use and understand base area symbols in grades one through six. However, at each grade level there was found to be a substantial range among the children in their ability to use and understand base area symbols.

11. Problems encountered by subjects in map drawing were generally concerned with the size of the symbol, the location of the symbol, and the proper type of symbol. It was not until after grade five that seventy-five percent of the sample obtained the maximum score of four for use of the base area symbol. Many of the subjects represented the buildings in profile rather than in plan. However, some children at the first and second grade, for example drew a plan of the model while others at the sixth grade represented the model in profile. Thus, a wide range in ages existed among children who could represent reality in plan.

12. In general, there was a sharp increase after grade two in the ability of children to use two and three-dimensional symbols to represent or interpret the reality of a scale model of a town. Subjects encountered difficulty in selecting the correct size of symbol, selecting the correct quarter of the model for symbol placement, and placing the symbols correctly on the block. Mirror images were common at the lower grades.

CHAPTER V

SUMMARY, CONCLUSIONS, IMPLICATIONS, AND SUGGESTIONS FOR FURTHER RESEARCH

I. THE STUDY

The purpose of this study was to examine the development of children's understanding of map symbolization in grades one through six. The spatial representation of the base area symbol, probably the simplest of all map symbols, was examined by means of the Base Area Symbols Test, constructed, administered, and scored by the investigator. This task-type test consisted of two series of tasks containing five and four tasks repectively designed to examine each subject's concept of base area symbols. A description of the test may be found in Appendix B. The Lorge Thorndike Intelligence Test, nonverbal form B was also administered as part of the test battery.

The sample of one hundred twenty children used in this study was composed of ten males and ten females at each grade from one through six at two schools in the Edmonton Public School System. The twenty subjects at each grade from one through six ranged in age from six years seven months to twelve years seven months and had intelligence quotients ranging from seventy-seven to one hundred forty-three as measured by the Lorge Thorndike Test. The children in the sample were classified into socio-economic status groups using the Blishen Occupational Class Scale.

The entire test battery was administered during the last two weeks of May and first two weeks of June, 1965. The appropriate level of the Lorge Thorndike Intelligence Test was administered in group sittings. The Base Area Symbols Test was administered to each subject in an individual test situation in a secluded room so there would be a minimum of interruption. The examiner was careful to see that the testing situation and the instructions did not vary from subject to subject.

After the investigator scored each of the tests, the data were placed on IBM cards. The statistical analysis, carried out by the IBM 7040 computer operated by the Department of Computing Science at the University of Alberta, was conducted to test the following hypotheses:

1. There is no significant correlation between the ability of males and females to represent three-dimensional objects by the use of base area symbols as measured by the Base Area Symbols Test.

2. There is no significant correlation between socio-economic status and the ability to represent three-dimensional objects by the use of base area symbols as measured by the Base Area Symbols Test.

3. There is no significant correlation between chronological age and the ability to represent three-dimensional objects by the use of base area symbols as measured by the Base Area Symbols Test.

4. There is no significant correlation between intelligence and the ability to represent three-dimensional objects by the use of base area symbols as measured by the Base Area Symbols Test.

5. There is no significant correlation between grade level and the

ability to represent three-dimensional objects by the use of base area symbols as measured by the Base Area Symbols Test.

6. There is no significant correlation between recent air travel experience and the ability to represent three-dimensional objects by the use of base area symbols as measured by the Base Area Symbols Test.

7. There is no significant correlation between the ability of males and females to visualize objects represented by base area symbols as measured by the Base Area Symbols Test.

8. There is no significant correlation between socio-economic status and the ability to visualize the objects represented by base area symbols as measured by the Base Area Symbols Test.

9. There is no significant correlation between chronological age and the ability to visualize the objects represented by base area symbols as measured by the Base Area Symbols Test.

10. There is no significant correlation between intelligence and the ability to visualize the objects represented by base area symbols as measured by the Base Area Symbols Test.

11. There is no significant correlation between grade level and the ability to visualize the objects represented by base area symbols as measured by the Base Area Symbols Test.

12. There is no significant correlation between recent air travel experience and the ability to visualize the objects represented by base area symbols as measured by the Base Area Symbols Test.

13. There is no significant correlation between the total score

obtained by each subject on section A of the Base Area Symbols Test dealing with the representation of three-dimensional objects by the use of base area symbols and the total score obtained by each subject on section B of the same test dealing with the visualization of objects represented by base area symbols.

The findings of this study are subject to the following assumptions and limitations. The entire study was based on the assumption that the tasks which comprised the Base Area Symbols Test were valid and reliable measures of the concept under investigation. The subject's overt behavior on each task was indicative of his understanding of the concept of base area sybmols. It was assumed that the method of scoring and the number of points assigned to each task were realistic and have been consistent throughout. The study was limited to the reading and interpretation of base area symbols, considered to be only one aspect of the many skills required in map reading. The study was limited to a sample of one hundred twenty children in grades one through six in two schools of the Edmonton Public School System.

II. SUMMARY AND CONCLUSIONS

The following conclusions may be drawn from the various findings of this study:

1. No significant relationship was found to exist between males and females and the development of the concept of base area symbols. This finding was in agreement with that of Towler who found that sex did not

appear to have any effect on the formation of concepts of scale, direction, distance, and a reference system. These concepts are aspects of map reading and were implicit in this study. However, this finding does not agree with Sheridan who found that boys scored significantly higher than girls on a study of map concepts through the use of pictures.

2. No significant relationship was found to exist between socio-economic status and the development of the concept of base area symbols. Vinacke in summarizing research dealing with concept formation, suggested that socio-economic status had a relationship, although low, to scores on concept tests. This study did not concur with Vinacke's conclusion. However, this finding did substantiate that of Towler that socio-economic status had no effect on concept formation.

3. A significant relationship was found to exist between chronological age and the development of the concept of base area symbols. This finding was in agreement with Vinacke's suggestion that chronological age was related to concept development. It was also in agreement with the finding of Towler that chronological age was significantly related to concept formation. While age was found to be significantly related to the development of the concept of base area symbols it should also be noted that there were wide ranges in the ages of children who could do each task as well as those who could not do each task.

4. There was a significant relationship between intelligence and the development of the concept of base area symbols. This finding concurred with the findings of Towler, Sheridan, and Vinacke. This finding was also

in agreement with that of Rushdooney who concluded that there was a high relationship between map reading achievement and intelligence.

5. Grade level was found to be significantly related to the development of the concept of base area Symbols. This finding substantiated the findings of Towler regarding concept formation and is probably linked with what Vinacke called experience or training.

6. There was not found to be any significant relationship between recent air travel experience and the development of the concept of base area symbols. In interpreting this finding it must be realized that the percentage of the sample having recent air travel experience was very small. In addition, the two years included as being recent may have resulted in some loss in value of this type of experience.

7. The ability to identify a photograph representing the "bird's eye view" of a model of reality was not developed until the end of the third grade. In this study seventy percent of the third, fourth, and fifth grade subjects were able to select the appropriate photograph while ninety percent of the sixth grade subjects could do so. This finding appeared to agree with Piaget's finding that until about the age of eight to nine years the child was bound by his spatial egocentrism and could not think of things relatively. It must be noted however, that in this study, forty and forty-five percent of the first and second grades respectively selected the correct photograph which possibly indicated that the spatial egocentrism did not hamper some children as long as it did others.

8. The concept of a map did not appear to be developed until after

the fifth grade. In this study, fifty percent of the sample at the fifth grade and seventy percent at the sixth grade selected the correct map of part of the model of reality. This appeared to agree with Piaget's finding that by stage IV the concept of a diagrammatic layout was acquired in a broad and general way. Twenty-five percent or less of the sample at each of grades one to four selected the correct map in this study which thus tended to further substantiate Piaget's claim.

9. In the drawing of a map, children in grades one through six had difficulty in determining both the type and size of symbol used to represent a model of reality. Many of the subjects represented the buildings by use of profiles. It was not until after the fifth grade that seventy-five percent of the sample used base area symbols to represent scale models of buildings. These findings concurred with those of Satterly who found that maps were often drawn showing buildings in elevation. These findings and observations closely parallelled those of Piaget who claimed that it was not until stage IV that a purely schematic plan was produced. However, it was found that a wide range in age and grade level existed among children who could represent models of reality in plan. This study, therefore, did not agree with Prior's finding that children could not produce a truly diagrammatic layout even at the mental age of twelve years six months. Sorohan's finding that a mental age of at least 131 months was required to master map symbols was not substantiated.

10. Children in grades one to six had difficulty with the location or representation of symbols relative to one another. Not until the

fifth grade did seventy-five percent of the sample obtain maximum scores for appropriate location of the symbol. This substantiated Satterly's claim that maps drawn by children showed difficulty in spacing of the objects in relation to each other.

11. A sharp increase occurred after grade two in the ability of children to use two and three-dimensional symbols to represent or interpret the reality of a scale model of a town. Generally, the problem encountered in the use of this form of symbolization involved selection of the correct size, correct placement of the symbols in relation to others surrounding it, and the correct orientation of the symbols in relation to the total area.

12. A number of instances of mirror images and reversals was noted in this study. This difficulty of orientation of symbols in relation to the total area involved was also observed by Satterly who indicated that sometimes left and right were confused, which may have caused the errors in spatial arrangement. This finding also concurred with the observation of Piaget that up until stage III the relationships of left-right, before-behind were not real to the child. In the lower grades, where problems of general orientation occurred most frequently, mirror images often resulted. Towler also found that young children often produced mirror images with little or no awareness that they were committing an error.

III. IMPLICATIONS

The results of this study have a number of educational implications.

1. Educators responsible for program development related to map reading should take cognizance of the level of conceptual development which is generally characteristic of the children at each school level. Further recognition must be given to the fact that there are various readiness levels for the development of the concept of map symbols at any one school level. With these two factors in mind, a long range sequential program of appropriate experiences should be developed. This program should be broad enough to provide for the children who have difficulty in acquiring the concept and must be flexible in nature so that individuals who are able to pass through each sequence more quickly are able to do so.

2. Teachers should be continually aware of the fact that children form concepts at various rates and that in any group of children there are substantial differences in the number and nature of experiences that individual children need in order to develop the concept of a base area symbol. Additional experiences should be given to those individuals who need it but advanced instruction should be available for those who are advanced.

3. In order to facilitate the development of the spatial concept experiences should be provided which require children to focus on the spatial arrangement of objects in three dimensions as well as their own position in relation to them. In model making and drawing, verbalization

should be encouraged so that children are able to indicate the changes in position, shape, and apparent size of objects with their own change in viewpoints. Verbal analysis of this nature could be incorporated into the art program.

4. The development of the concept of base area symbols could probably be facilitated by experiences involving analysis of shapes such as those used in experiments by Piaget. For example, the drawing and verbal analysis of an imaginary cut through various sections of such objects as a cube, a ball, or cylinder, and a cone are experiences which would probably aid the development of the concept of a plan of a building.

5. The problem of mirror images has long been associated with reading and writing difficulties. Educators should be aware that the problem is associated with map symbolization. Task-type experiences involving the placement of three and two-dimensional objects should probably be used in situations where a mirror image makes the placement impossible such as in a jig-saw puzzle.

6. The problems encountered in orientation or proper location of objects may be remedied by systematic picture study. Terminology signifying general location on the picture should be developed so that the left-right, before-behind relationships can be established. The same terminology could then be transferred to map and/or model study.

7. Specific suggestions to aid development of the concept of base area symbols have been given above. However, a sequential program for the development of this concept cannot be outlined because the hypothesis that the nine tasks that comprised the Base Area Symbols Test were in order of

difficulty from easiest to hardest was not substantiated. According to the results of this investigation children should begin with a map and work back to the reality before beginning with the reality and constructing a map. Such a sequence would certainly be in contradiction to commonly accepted procedures in reading and arithmetic and those outlined earlier in this study.[1]

IV. SUGGESTIONS FOR FURTHER RESEARCH

This study has presented a number of tentative answers to some of the questions dealing with the concept of base area symbols. In addition, it has opened up a number of related areas which require further research. Some of these suggestions for further research are presented below.

1. This study has been limited to the development of the concept of base area symbols. Research is needed in at least three other related aspects of symbolization. First, concept development of symbols of other cultural features such as roads, bridges, power lines, etc. needs to be examined. Second, the representation and visualization of physical features by children merits investigation. Third, the symbolic representation through use of color requires investigation. Various relationships among these four types of symbolization might add a fourth study.

2. Base area symbols are only one form of symbolization. What is the relationship between children's ability to visualize from maps and other forms of symbolization such as graphs, diagrams, and cartoons?

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[1] Supra.

3. This study has found that while some children at the first and second grade drew a schematic plan of the model, others as late as the sixth grade level represented the buildings of the model in profile. What factors affected this difference in ability in children of substantially different age and grade? Is the concept of map base area symbols learned? If so, what is the best method of teaching these concepts? What types of materials are needed? Does kindergarten or playschool experience aid in the development of this concept?

4. According to the findings of this study, recent air travel experience was not significantly related to the development of the concept of base area symbols. Due to the small number of children in this sample having had air travel experience, it may be profitable to investigate this aspect further. Does the experience of viewing reality from atop a high building, for example, aid in developing the base area concept?

5. Vinacke's claim that socio-economic status is a factor related to concept development was not substantiated by this study. Further research to determine the exact nature of this relationship might be profitable.

6. In a number of the tasks completed by children in this study the younger children especially produced a number of mirror images. What factors account for this phenomenon? Do these children have a parallel difficulty in reading?

7. Revision of and re-testing with the Base Area Symbols Test might be undertaken so that a refined version of it might be available

to test for the development of this concept in all elementary school children.

8. Vinacke's claim that experience is related to concept development was not considered in this study. It might be profitable to structure various types of experiences for children designed to aid in the development of the concept of base area symbols and then determine the effectiveness of such experiences through appropriate testing.

This entire study and the suggestions for further research noted above are but a sample of the many and varied aspects of children's thinking in relation to map reading and interpretation that need to be explored further. Other areas of investigation may probably become apparent to the reader from the discussions in this study. The hope of the investigator is that this enquiry may serve to initiate further studies so that evidence can be accumulated which will make it possible to develop sequences of instruction in mapping and to incorporate other appropriate changes in the mapping aspects of social studies curricula.

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APPENDIX A

University of Alberta
Faculty of Education
Edmonton, Alberta
May, 1965

Dear _____:

We are pleased to inform you that your child, _____, has been chosen to participate in a project designed to improve the education of elementary school children. We are endeavouring to discover what thought processes children use when they work with maps, in order that additional research evidence may be brought to bear on the problem of designing learning materials suited to children's needs. By participating in this project, your child will contribute greatly to its success.

We should also like to assure you that this project has been approved by the Edmonton Public School Board and that the small amount of time required of your child will in no way interfere with his regular schooling. Rather, participation in this project may be regarded as an educational experience in itself.

The results of any tests administered will be held in strictest confidence and will in no way reflect learning ability or school potential. In any event, no child will be identified when the results of the study are published.

We hope that this letter will explain the activities your child will be engaged in. However, if you have further questions please feel free to contact us at the University (phone 438-8721, locals 743 or 663).

Sincerely,

J. O. Towler
M. L. Pedde

APPENDIX B

BASE AREA SYMBOLS TEST

The basis for all tasks in this test is a three-dimensional model town consisting of four blocks of buildings (See Figure 1). The base of the town is made of plywood and the blocks, made of masonite, are attached forming a street intersection at the centre. For convenience, the blocks are numbered 1 to 4 inclusive (See Figure 1). The blocks are 12 inches by 18 inches with a triangular piece of each cut off at the intersection. Three or four buildings are placed on each block and a number of trees complete the three-dimensional aspect of the model. The model is placed on a table thirty inches in height. A recording sheet (See Appendix C) is provided for convenience.

SECTION A

1. Photograph Identification (Task 1)

Apparatus: Six photographs (See Figures 2, 3, 4, 5, 6, 7) are placed on a table to the left of the model of the town.

"Here is a little town which has four blocks, two streets, a number of houses and other buildings and a number of trees. Look carefully at the little town for a minute. (Pause) On this table are six photographs of this little town. One of them could have been taken by a man flying over this town in a helicopter. (Hold a toy helicopter over the center of the town approximately 30 inches above.) Look at the photographs carefully and then tell me which one could have been taken by a man flying right over the town in a helicopter." (Pause) After selection ask, "Why?" Record choice and reply.

2. Map Selection (Task IV)

Apparatus: Five cards (See Figures 8, 9, 10, 11, 12), two of which are maps and three which are profiles of one block of the model town are placed on the table to the left of the model town. A cardboard screen is placed on the model so that only block 3 (See Figure 1) is visible.

"Here are five cards. One of them is a correct map of this one block (Point) of the town. Look at the cards carefully and then tell me which one is a correct map of the block". (Pause) "Why?" Record selection and reply if any.

3. Map Drawing (Task V)

Apparatus: One sheet of white paper, twelve inches by eighteen inches, and a box containing a small ruler, cardboard strips 1 x 4, 1 x 6, 1 x 10, a pencil, and one crayon of each: red, blue, green, black, green, blue, and orange, are placed on the table to the left of the model. The screen remains to expose the same blocks used in task IV.

"Here is a sheet of paper and a box of pencils and other things. Use as many of the things you wish to draw a map of this block (Point) of the little town. Please take about ten minutes to draw a map of this one block".

4. Three-Dimensional Symbols (Task II)

Apparatus: A duplicate base of the town including the buildings and trees (hereafter called the base) is placed on the table to the left of the model town. On a table to the left of the subject are styrofoam three-dimensional symbols in the following quantities and sizes:

2 - 3-1/2" x 3" x 2-1/2", 3 - 3" x 6" x 2-1/2", 1 - 3" x 4" x 2-1/2", 1 - 3-1/2" x 6" x 3", 1 - 4" x 5" x 3", 1 - 3" x 6" x 1", 1 - 3" x 6" split level.

"Here is the start of a new town (Point to the base) that has streets and four blocks just like this little town. We want to build up this new town so it is exactly like this model. On the table beside you are some "pretend" buildings. I want you to use these "pretend" buildings to build up this same block (Point) on the new town. Put as many as you need on the new town to show me exactly where and how big the buildings would be." Record the size and placement of symbols on the block used.

5. Two-Dimensional Symbols (Task III)

Apparatus: The base used in task II remains in position. On a table to the left of the subject are piles of two-dimensional symbols made of thin white cardboard in the following quantities and sizes: 3 - 3" x 3", 2 - 3" x 4", 1 - 3" x 5", 4 - 3" x 6", 1 - 3" x 10", 4 - 3-3/4" x 6", 1 - 4" x 5", 1 - 4" x 6".

"Here is a new town (Point to the base) that has streets and four blocks just like this little town. We want to build up this new town so it is exactly like the model. On the table beside you are some cards which I want you to use to show me where and how big the buildings of this block (Point) should be. Take as many cards as you need and put them on your new town to show me where, and how big, the buildings should be." Record the size and placement of the symbols on the block used.

Section B

The basis for the tasks in Section B is a large map of the four-block town used for all tasks on Section A. (See Figure 13) For the first three tasks a brown paper is used to cover blocks 1, 3, and 4 of the map. The base used on Section A is again used as the answer sheet.

1. Two-Dimensional Symbols (Task VI)

Apparatus: A large map of a four-block town, three blocks of which are covered by a brown paper screen, is placed on the table. On the table to the left of the map is the base used in section A. On a small table to the left of the subject are two-dimensional symbols in the following quantities and sizes: 3 - 3" x 3", 2 - 3" x 4", 1 - 3" x 5", 4 - 3" x 6", 1 - 3" x 10", 4 - 3-3/4" x 6", 1 - 4" x 5", 1 - 4" x 6".

"Here is a map of a little town. (Show the entire map.) It has four blocks, streets, and buildings much like the little town we saw a while ago. I'm going to cover up three of the four blocks and just leave this one uncovered. (Point) We want to build up the same block on your town (Point) to show where and how big the buildings should be. Take as many cards as you need and put them on your town to show me exactly where and how big the buildings of the block should be." Record the size and placement of the symbols on the blocks used.

2. Three-Dimensional Symbols (Task VII)

Apparatus: The apparatus is the same as used in task VI except that the cards are replaced with three-dimensional symbols in the following quantities and sizes: 2 - 3" x 3" x 2-1/2", 3 - 3" x 6" x 2-1/2",

1 - 3" x 4" x 2-1/2", 1 - 3-1/2" x 6" x 3", 1 - 4" x 5" x 3", 1 - 3" x 6" x 1", 1 - 3" x 6" split level.

"Here is the same map of a little town with three of the four blocks still covered. We want to build up the same block on your little town by using these "pretend" buildings. Put as many of these as you need on your town to show me exactly where and how big the buildings should be." Record the size and placement of symbols on the block used.

3. Scale Models (Task VIII)

Apparatus: The apparatus is the same as used in task VI and VII except that the symbols are replaced by realistic buildings in the following quantities and sizes: 2 - 3" x 6" (one storey), 1 - 3" x 3" (one storey), 1 - 3" x 4" (one storey), 1 - 3" x 4" (two storeys), 1 - 3" x 6" (two storey).

"Once again, here is the same map of a little town with the same three blocks covered. We want to use these toy buildings (Point to the buildings) to build up this block (Point to blocks on map) on your little town. Put as many of these buildings as you need on your town to show me where and how big the buildings should be and what they might really look like." Record the size and placement of the realistic buildings on the block used.

4. Symbol Identification (Task IX)

Apparatus: The large map of a four-block town used in tasks VI, VII, and VIII is placed on the table. To the left of the map is placed the corresponding vertical photograph. (See Figure 3)

"Here is a photograph and map of a little town. I'm going to place a number on four different buildings shown on the map. I want you to point to the building in the photograph (Point to the photograph) which is shown by each number placed on the map. Now show me which building is marked by number one, two, three, and four." Record choice and location.

APPENDIX C

Name _____ School _____
Grade _____ Sex _____ Parental Occupation _____
C.A. _____ Code _____ Air Travel _____

SECTION A

1. Correct photograph 1 2 3 4 5 6

2. 3D Symbols
   a) No. of symbols _____ Quad. _____
   b) Size _____ _____
   c) Orientation _____ _____

3. 2D Symbols
   a) No. of symbols _____ _____ _____
   b) Size _____
   c) Orientation _____ _____

4. Map Selection 1 2 3 4 5

5. Map Drawing
   a) No. of symbols _____
   b) Size _____
   c) Base area only _____
   d) Orientation _____

   Observations: _____

   _____

SECTION B

1. 2D Symbols Quad. _____
   a) No. of symbols _____ _____
   b) Size _____
   c) Orientation _____ _____

2. 3D Symbols _____
   a) No. of symbols _____ _____
   b) Size _____
   c) Orientation _____ _____

3. Scale Models _____
   a) No. of objects _____ _____
   b) Size _____
   c) Orientation _____ _____

4. Symbols identification 1 2 3 4 _____

   Observations: _____

   _____

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